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FINAL REPORT

OLD CITY LANDFILL
COLUMBUS, INDIANA
FEASIBILITY STUDY

Prepared for:

Old City Landfill PRP Group
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July, 1991

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Geraghty & Miller, Inc. appreciates the opportunity to work for the Old City Landfill PRP Group at the Old City Landfill located in Columbus, Indiana. If you have any questions or comments concerning this report, please contact one of the individuals listed below.

Respectfully submitted,

GERAGHTY & MILLER, INC.

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EXECUTIVE SUMMARY

The Old City Landfill (OCL), located in Columbus, Indiana, operated primarily as a municipal waste landfill from approximately 1938 until it stopped accepting waste in the mid to late 1960s. During its period of operation, the OCL reportedly accepted industrial and commercial wastes from various sources in and around the City of Columbus. Due to the release and/or threats of release of hazardous substances from the OCL, the United States Environmental Protection Agency (USEPA), following National Contingency Plan Regulations, placed the OCL on the National Priorities List (NPL) of abandoned hazardous waste sites. Following this action, an Administrative Order by Consent became effective on November 5, 1987 between the USEPA, the Indiana Department of Environmental Management (IDEM), and a group of potentially responsible parties (PRPs).

The Administrative Order required that the PRPs conduct a remedial investigation (RI) to determine the nature and extent of release or substantial threat of release of hazardous substances, if any, from the OCL site. The Administrative Order also required the PRPs to perform a feasibility study (FS) to develop and evaluate remedial alternatives that could be implemented to abate the release of hazardous substances, if any, from the OCL site. Geraghty & Miller was retained by the Old City Landfill Steering Committee, formed by a number of the identified PRPs, to conduct the remedial investigation/feasibility study (RI/FS).

The completed remedial investigation characterized the nature and extent of any contamination present in the environmental media (i.e., air, soil, ground water, surface water, etc.) surrounding the OCL. Based on this characterization, a baseline risk assessment was performed to evaluate the potential risks to human health and the environment, associated with the OCL, that would persist if remedial action were not taken. The Final Remedial Investigation Report, dated July, 1990, summarized the site characterization, nature and extent of contamination, and the present risks to human health and the environment associated with the OCL.

The findings and conclusions reached from the remedial investigation and baseline risk assessment were used as the basis for conducting the feasibility study. The purpose of the feasibility study was to develop and analyze viable remedial alternatives that could be implemented to ensure the protection of human health and the environment. The results of conducting the feasibility study are presented in this Final Feasibility Study Report.

The initial task in conducting the feasibility study involved the evaluation of the environmental media surrounding the OCL in order to establish which of the media would necessitate remedial action. By comparing the results of the RI against the maximum allowable contaminant concentration limits for the various media, as well as acceptable health-based and environmental quality-based guidelines, it was concluded that the various media surrounding the OCL do not require corrective remedial action. Based on the results of the RI, it has been further concluded that significant contaminant releases from the OCL are not occurring and residuals from past releases are not evident in the media surrounding the OCL. This is consistent with the baseline risk assessment which concluded that the risks associated with the OCL, in its present condition, are within acceptable health-based and environmental quality-based guidelines.

Considering the evaluation of environmental media, as well as the potential future risks associated the OCL, a series of remedial response objectives were formulated. The remedial response objectives focus on source control to ensure the continued protection of human health and the environment. A wide range of remedial technologies were then screened for applicability to the remedial response objectives as well as the site conditions. The remedial technologies deemed applicable were used in formulating a series of viable remedial alternatives.

Based on a request made by the PRP's and approved by USEPA and IDEM, the developed remedial alternatives for the OCL site incorporate the potential placement of a roadway over the OCL. Placement of a roadway is considered as a result of plans developed by the Indiana Department of Transportation (INDOT), in cooperation with the City of Columbus, that necessitate having a section of rerouted State Highway 46 pass over the northwest section of the OCL. This FS report describes the preliminary design of the roadway and predicts how placement of the roadway may impact each of the developed alternatives. In order to obtain a better understanding of how the proposed roadway may impact the OCL and any of the potential remedies, a preload testing program is currently being conducted by INDOT in cooperation with the PRP's, USEPA and IDEM. In addition, INDOT is currently modifying the roadway design to allow for a shorter roadway embankment than originally proposed.

The results of the preload testing program as well as a discussion of the final design specifications for the roadway will be presented in a technical supplement to the FS. The technical supplement will also discuss to what degree, if any, the preload test results and roadway design changes impact the assessment of remedial alternatives presented in this FS report. The roadway design specifications presented in the technical supplement shall supercede those presented in this FS report. Although the proposed roadway and bridge has complicated the feasibility study, the potential for incorporating the roadway and bridge into the OCL remediation offers the distinct advantage of providing beneficial land use of the OCL property which otherwise would be left unused for the foreseeable future.

In order to assess a wide range of remedial action for the OCL, the alternatives that were developed include alternatives that would provide, collectively or independently, no-action, waste containment, and/or waste treatment. The remedial alternatives that were developed for the OCL are as follows:

Alternative 1:	No Action
Alternative 1A:	Roadway Placement with No Action
Alternative 2:	Institutional Controls
Alternative 2A:	Roadway Placement with Institutional Controls
Alternative 3:	Sanitary Landfill Cap
Alternative 3A:	Roadway Placement with Sanitary Landfill Cap
Alternative 4:	RCRA Subtitle C Cap
Alternative 4A:	Roadway Placement with RCRA Subtitle C Cap
Alternative 5:	On-Site Solidification/Stabilization
Alternative 5A:	Roadway Placement with On-Site Solidification/Stabilization

The developed alternatives were taken through a detailed analysis process where the alternatives were evaluated, both individually and collectively, against evaluation criteria established by the USEPA. Analysis of the alternatives yielded the advantages and disadvantages of each alternative relative to such criteria as overall protection of human health and the environment, compliance with federal and state regulations, short-term and long-term effectiveness, implementability, costs, etc. A comparative analysis of the alternatives was used as the basis for assessing the relative performance of each alternative with respect to the evaluation criteria.

From the detailed analysis procedure, it was concluded that Alternatives 1 and 1A would not ensure the overall protection of human health and the environment since there would be no means to identify and mitigate any increased risks that could result from contaminant releases occurring some time in the future. Due to the increased potential for leachate generation (i.e. the liquid that is derived by water percolating through or being compressed out of the buried waste material) as a result of waste material compaction by the roadway fill material, Alternative 1A would provide a slightly lower degree of overall protection than would Alternative 1. Since

Alternatives 1 and 1A would not adequately ensure the continued protection of human health and the environment, it is recommended that neither be selected as the final remedy for the OCL.

The detailed analysis further concluded that the institutional controls provided under Alternatives 2 and 2A would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases. As a result of the monitoring and inspection measures that would be implemented, appropriate remedial action would be taken if contaminant releases were to occur some time in the future. To abate any environmental impacts caused by any generation of leachate from placement of the roadway, Alternative 2A would include additional control measures (i.e. leachate seep inspections and the development of a ground-water recovery system contingency plan) to ensure the same degree of overall protection provided by Alternative 2.

In assessing the alternatives it was concluded that enhanced waste containment, as would be provided by an Indiana Sanitary Landfill Cap for Alternatives 3 and 3A or a RCRA Subtitle C Cap for Alternatives 4 and 4A, would not offer any significant increase in benefits over that provided by institutional controls. The reason for this is that the existing landfill cover, which supports a full vegetative cover and does not show signs of erosion, potentially provides adequate surface containment of the waste material. In placing either a Sanitary Landfill Cap or a RCRA Subtitle C Cap over the OCL, however, the waste material may become exposed during regrading of the existing cover materials, potentially causing contaminant releases. In addition, the reduction in water infiltration that would be realized with either a Sanitary Landfill Cap or a RCRA Subtitle C Cap would most likely provide only marginal benefits since the RI did not detect significant releases of contaminants into the ground water even though water infiltration has passed through the existing landfill cover and waste material over the years. This lack of leaching of contaminants into the ground water due to water infiltration is consistent with the constituents identified in the waste material. The waste material analysis conducted as part of the RI indicates the vast majority of the constituents of concern in the waste material are heavy metals, which, apart from airborne releases, are for the most part relatively immobile in the environment. The waste material analysis only detected minor concentrations of organic constituents, which are generally much more mobile in the environment than are heavy metals.

The screening of remedial technologies concluded that, considering the large volume, waste character, and heterogeneous nature of the waste material, only on-site solidification/stabilization represented a potentially viable treatment alternative for the OCL. However, the detailed analysis of Alternatives 5 and 5A, which provide for on-site solidification/stabilization, concluded that treatment of the waste material would have a very low degree of cost-effectiveness and could substantially increase the risks to human health and the environment during implementation of the remedial action. The increased risks to human health and the environment would result from the necessity of having to excavate and pulverize up to 500,000 cubic yards of waste material. This process would likely cause significant contaminant releases, thus potentially endangering human health and the environment.

1.0 INTRODUCTION

The Old City Landfill (OCL), located in Columbus, Indiana, operated primarily as a municipal waste landfill from approximately 1938 until it stopped accepting waste in the mid to late 1960s. During this period of operation, the OCL reportedly accepted industrial and commercial wastes from sources in and around the City of Columbus. Due to the release and/or threats of release of hazardous substances from the OCL, the United States Environmental Protection Agency (USEPA), following National Contingency Plan (NCP) regulations, placed the OCL on the National Priorities List (NPL) of abandoned hazardous waste sites. Following this action, an Administrative Order by Consent (hereafter referred to as the Administrative Order) became effective on November 5, 1987 between the USEPA, the Indiana Department of Environmental Management (IDEM), and a group of Potentially Responsible Parties (PRPs) in accordance with sections 122(a) and (d)(3) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The respondent PRPs to the Administrative Order include Cummins Engine Company, Arvin Industries, and the City of Columbus.

The Administrative Order required that the PRPs conduct a remedial investigation (RI) to determine the nature and extent of release or substantial threat of release of hazardous substances, if any, from the OCL site. The Administrative Order also required the PRPs to perform a feasibility study (FS) to develop and evaluate remedial alternatives that could be implemented to abate the release of hazardous substances, if any, from the OCL site. Geraghty & Miller, Inc. (G&M) was retained in September, 1987 by the Old City Landfill Steering Committee, formed by a number of the identified PRPs, to conduct the remedial investigation/feasibility study (RI/FS).

The draft of the Remedial Investigation Report dated January 29, 1990, has been reviewed by both the USEPA and IDEM. The Remedial Investigation Report was revised to reflect the comments presented by the regulatory agencies. The Final Remedial Investigation Report, dated July, 1990 has been submitted to, and approved by, the regulatory agencies.

1.1 PURPOSE

This document constitutes the Final Feasibility Study Report. This final version of the Feasibility Study Report, which was approved by USEPA in their letter dated May 31, 1991, addresses and/or incorporates the comments presented by the regulatory agencies following their review of the previously submitted Feasibility Study Reports. Consistent with the Administrative Order and the approved Final Work Plan (G&M 1987), both a Preliminary Draft Feasibility Study Report, dated July 19, 1990, and a Draft Feasibility Study Report, dated October 8, 1990, were previously submitted to the regulatory agencies. In addition, two revised versions of the Draft Feasibility Study Report, one dated February 11, 1991 and the other dated May 15, 1991, were also submitted to the regulatory agencies as part of the feasibility study approval process.

The remedial investigation characterized the nature and extent of any contamination present in the environmental media (i.e., air, soil, ground water, surface water, etc.) surrounding the OCL. Based on this characterization a baseline risk assessment was performed to evaluate the potential risks to human health and the environment, associated with the OCL, that would persist if remedial action were not taken. The Remedial Investigation Report summarized the site characterization, nature and extent of contamination, and the present risks to human health and the environment associated with the OCL.

The findings and conclusions reached from the remedial investigation and baseline risk assessment were used as the basis for conducting the feasibility study. The purpose of the feasibility study is to develop and analyze viable remedial alternatives that could be implemented to ensure the continued protection of human health and the environment at the OCL site. The feasibility study has been conducted in accordance with both the requirements identified in the Administrative Order Statement of Work (hereafter referred to as the Statement of Work) as well as those listed within the latest revision of the NCP (40 CFR 300, Subpart E), effective April 9, 1990. The recommendations contained within the USEPA document Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, October, 1988 (hereafter referred to as the USEPA RI/FS Guidance Document) were also closely followed in conducting the feasibility study.

In order to develop viable remedial alternatives, the environmental media surrounding the OCL were first evaluated to establish which of the media would necessitate remedial action. From this evaluation a set of appropriate remedial response objectives were developed. A wide range of remedial technologies were then screened for applicability to the remedial response objectives as well as the site conditions. The remedial technologies deemed applicable were used in formulating the viable remedial alternatives.

The viable remedial alternatives have been taken through a detailed analysis process which has yielded the relative advantages and disadvantages of each alternative. This detailed analysis will form the basis for selecting the final remedy for the OCL.

Prior to completing the feasibility study an Alternatives Array Document, dated April 18, 1990, was prepared and submitted by G&M. A letter supplementing the Alternatives Array Document was submitted to the agencies by G&M on June 18, 1990. The function of the Alternatives Array Document was to assist the regulatory agencies in identifying all applicable or relevant and appropriate requirements (ARARs) for the developed remedial alternatives and have the agencies provide their comments and/or concurrence on the remedial response objectives. The alternatives array document review comments, including a listing of the identified ARARs, were issued by the regulatory agencies on June 25, 1990. These regulatory agency review comments and identified ARARs are reflected in this report.

1.2 REPORT ORGANIZATION

This report is organized into five sections. Section 1.0 provides an introduction to this report and the remaining sections are briefly described below.

Section 2.0, **Site Characterization**, presents a summary of the findings and conclusions reached from the remedial investigation and discusses the incorporation of a proposed roadway into the feasibility study process.

Section 3.0, **Development of Remedial Response Objectives**, evaluates the environmental media potentially impacted by the OCL and presents the remedial response objectives and general response actions that have been developed.

Section 4.0, **Identification and Screening of Remedial Technologies**, discusses the process used for evaluating remedial technologies and identifies both applicable and inapplicable remedial technologies.

Section 5.0, **Development and Detailed Analysis of Alternatives**, identifies the remedial alternatives that have been developed, discusses the detailed analysis procedure, describes and evaluates each of the remedial alternatives, and then compares all of the remedial alternatives.

2.0 SITE CHARACTERIZATION

Site characterization includes a description and history of the site, a summary of the remedial investigation, the nature and extent of the contaminants detected in all media, identification of exposure pathways and receptors for these contaminants, and a discussion on how a proposed roadway has been incorporated into the feasibility study.

2.1 SITE DESCRIPTION

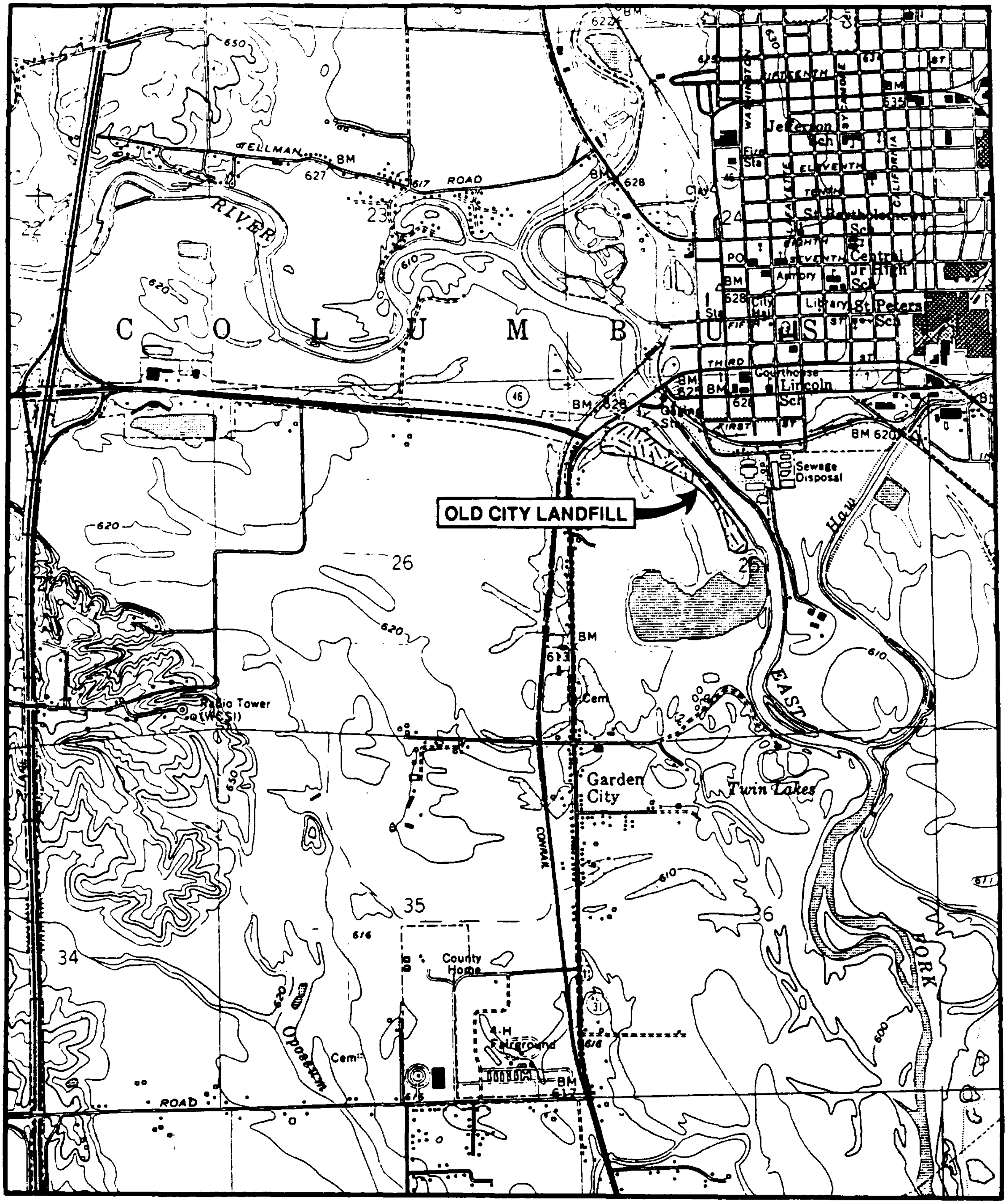
This section presents a summary of the physical characteristics of the OCL site.

2.1.1 Site Location

The OCL is located approximately 1/4 mile southwest of the City of Columbus in Section 25, Township 9 north, Range 5 east in Bartholomew County, Indiana. The OCL is bounded by farmland and State Route 11 to the west, the 3rd Street Bridge to the north, the East Fork of the White River to the east, and a gravel quarry pond to the south. The area between the OCL and the East Fork of the White River is a floodplain and it's vegetation generally consists of grass/small shrubs and moderate tree cover. Refer to Figures 2-1 and 2-2 for the regional and local setting of the OCL.

2.1.2 Extent of Waste Material

The portion of the site containing waste material parallels the river and covers approximately 19 acres. As stated in the approved RI Report (G&M 1990a), the landfill cover material is composed of a mixture of brown to black silty sand and clay which was dredged from the East Fork of the White River. The landfill cover material is generally 2 to 3 feet in thickness



SOURCE: USGS 7.5 Minute Topographic Map COLUMBUS, IN Quadrangle 1980

N

0 1000 2000 4000

SCALE IN FEET

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FIGURE 2–1
SITE LOCATION MAP
OLD CITY LANDFILL
COLUMBUS, INDIANA

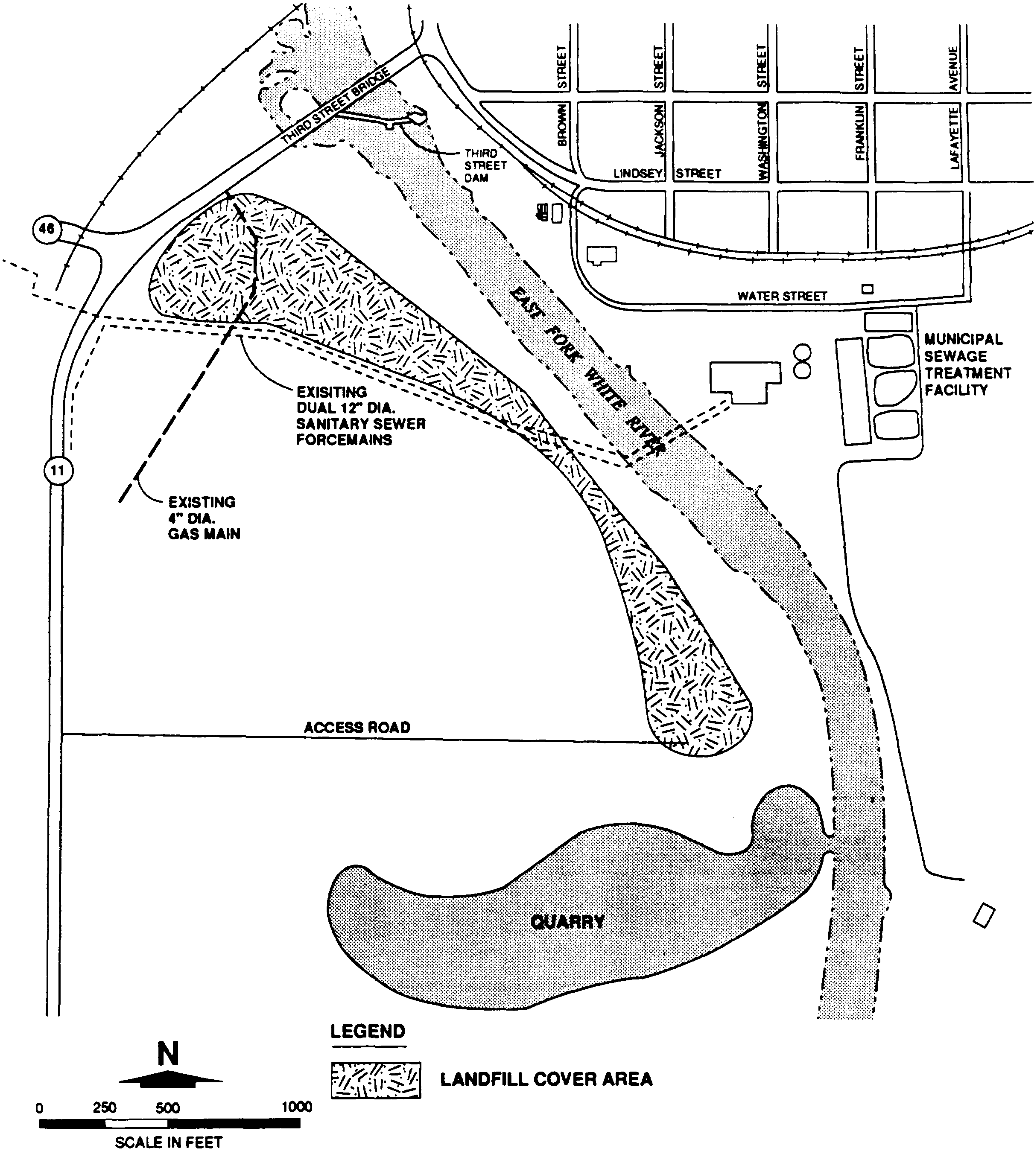

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FIGURE 2-2
SITE CONFIGURATION MAP
OLD CITY LANDFILL
COLUMBUS, INDIANA

across the site, however, 4 to 5 feet of the cover material is present near the locations of Monitoring Wells GMMW-01 and GMMW-02. Based on soil boring data, the depth of the landfill material averages approximately 17 feet over the area of the landfill. Thus, the total volume of the fill material within the landfill is estimated to be 500,000 cubic yards. As shown on Figure 2-3, land surface elevations range from approximately 625 feet above mean sea level (msl) at the top of the fill area to 600 feet above msl at the river. The landfill surface supports a full vegetative cover of native grasses and weeds that is maintained by the present property owner. Presently, there are no buildings or other structures on the landfill.

2.1.3 Hydrology

The East Fork of the White River flows southward along the northwest and east border of the landfill. Surface runoff from the area encompassing the landfill drains into the East Fork of the White River or the cultivated fields to the west. The inactive gravel quarry, which covers an area of approximately 35 to 40 acres and is located near the southeast corner of the OCL, is hydrologically connected to the river through a relatively short, narrow open channel (G&M 1990a).

According to information provided by the Indiana Department of Natural Resources (IDNR), Division of Water, the OCL site is located in the 100-year flood plain of the East Fork of the White River. From evaluation of the flood profiles, the 100-year flood elevation level at the site varies from approximately 618 feet near the southern extent of the landfill to 621 feet near the northern extent of the landfill. Figure 2-4 presents the extent of the 100 year flood plain in the vicinity of the OCL.

The surface of the surficial soil that covers the waste material varies from an elevation of approximately 612 feet near the edges of the landfill to approximately 625 along the north-

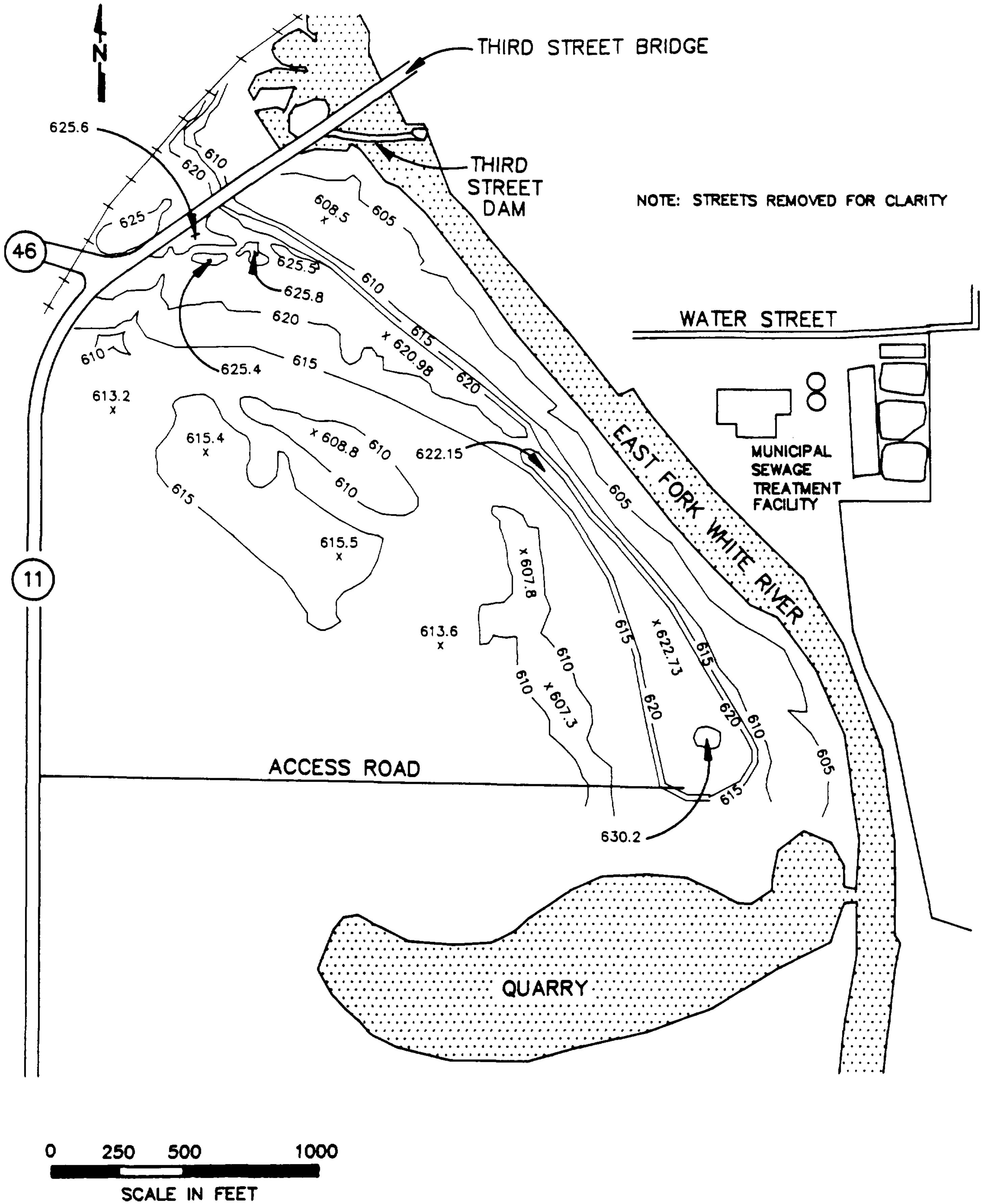

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FIGURE 2-3
EXISTING SURFACE ELEVATIONS
OLD CITY LANDFILL
COLUMBUS, INDIANA

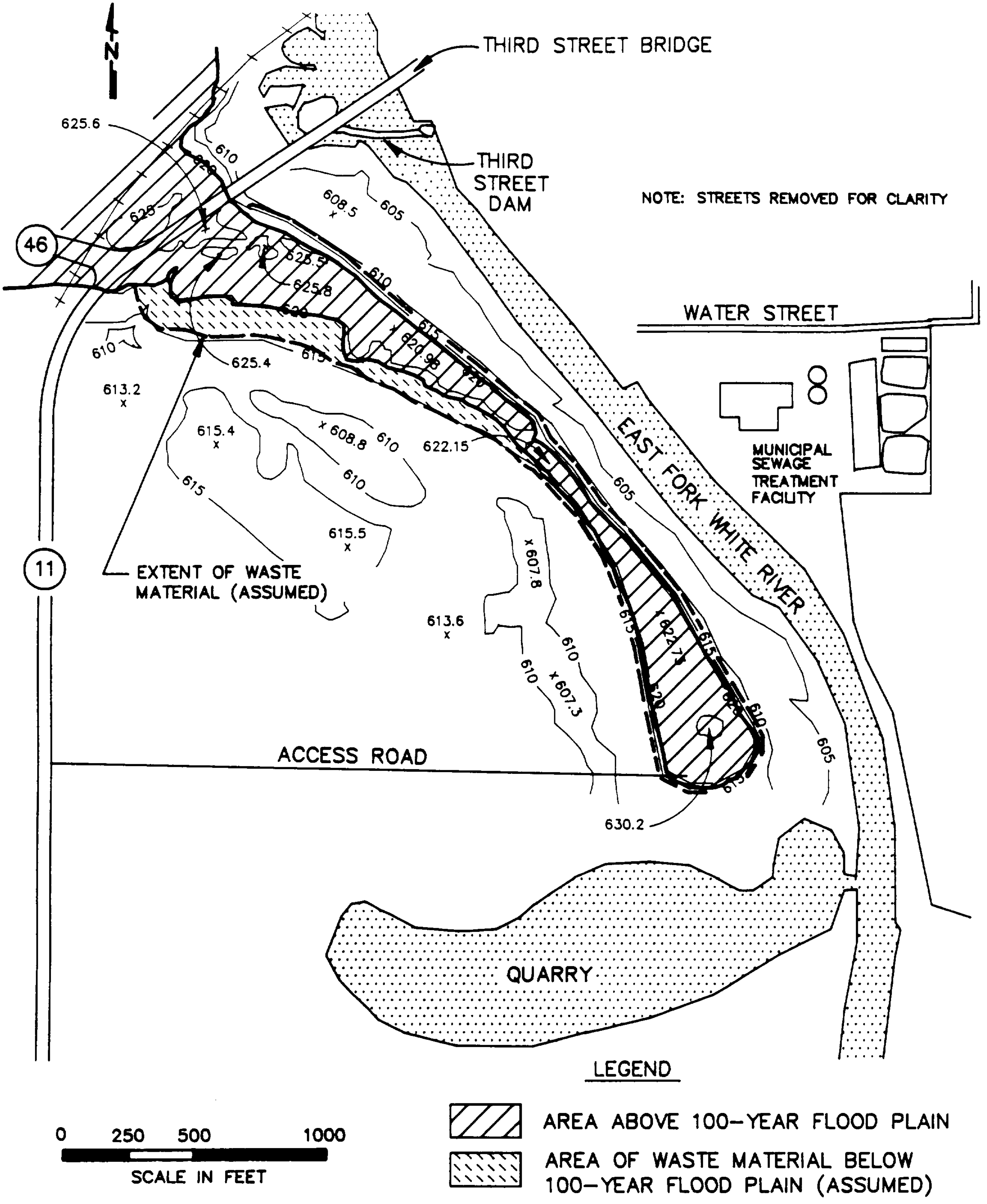

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FIGURE 2-4
EXTENT OF 100-YEAR FLOOD PLAIN
OLD CITY LANDFILL
COLUMBUS, INDIANA

eastern crest of the landfill. Thus, a portion of the surficial soil that overlies the waste material would be submerged during a 100-year flood occurrence.

2.1.4 Geology

The OCL and immediately adjacent areas are underlain by a complex heterogeneous deposit of unconsolidated recent and Pleistocene age materials. A detailed description of the site specific geology is presented in Section 2.3.3.1.

2.1.5 Hydrogeology

Ground water beneath the site exists within a shallow aquifer which consists of the unconsolidated materials described above. A description of the hydrogeologic conditions at the OCL is presented in Section 2.3.3.2.

2.1.6 Land Use

Current land use in the immediate vicinity of the OCL is variable. The northwest section of the OCL property is used as a target practice shooting range, and the southeast portion of the property is currently leased to a concrete mixing operation. However, neither the shooting range nor the concrete mixing operation are located on, or immediately adjacent to, the landfill. The City of Columbus publicly owned treatment works (POTW) (i.e. sewage treatment facility) is located directly across the river. Dividing the landfill at its approximate midpoint are two 12 inch diameter, asbestos cement, sanitary sewer lines that extend across the river to the POTW. The two sanitary sewer lines are currently in use and operate as force mains. The lines are owned and maintained by the Columbus City Utilities and are purportedly located within or below the waste material. A currently active, four inch diameter steel gas main, owned and operated by Indiana Gas, also underlies the landfill near its northwestern end. The approximate locations of the sewer and gas lines are shown in Figure 2-2. The PRP group is currently planning to initiate conversations with both the Columbus City Utilities and Indiana Gas to start procedures for the abandonment of the sewer and gas lines underlying the landfill. By abandoning these lines, the need to excavate waste material as a result of a leak developing in either of the lines will be eliminated.

2.1.7 Climate

The climate in the Columbus area is temperate, with annual temperatures ranging from approximately 26°F in January to 78°F in July (National Climatic Data Center 1988). The area normally receives 39 inches of precipitation annually which is distributed at a fairly even rate throughout the year. Wind directions at the OCL occur most frequently from the southwest to the northeast.

2.2 SITE HISTORY

The OCL operated as a municipal landfill from about 1938 to the mid to late 1960s. Material deposited in the landfill was mainly municipal and household wastes, although waste from industrial sources was also reportedly disposed of in the landfill. No records of site operations were kept. Public dumping was not permitted; however, the site was not secured and limited dumping by unauthorized parties may have occurred.

The waste material dumped at the OCL was placed directly on the ground surface. The ground surface was not lined prior to the initiation of dumping activities nor was excavation accomplished to create disposal pits. Open burning of the waste material occurred regularly which often allowed odors to migrate across the river into the city. The waste material was not consistently contained under daily cover and, thus, was frequently exposed to the elements.

The disposal area was subjected to annual flooding during the springtime which most likely caused the waste material to occasionally become submerged in the flood waters. Upon additional placement of waste material, the landfill began to function as a berm between the floodplain and the farmland located west of the landfill. After reaching a maximum waste placement height of approximately 20 feet, operation of the landfill was halted. As a means for closing the landfill, dredged sediment from the river consisting primarily of silty sand and clay was placed over the entire extent of the landfill. As stated in the approved RI Report (G&M 1990a), the landfill cover material, which supports a full vegetative cover, is generally 2 to 3 feet in thickness across the landfill, however, 4 to 5 feet of cover material is present near the locations of Monitoring Wells GMMW-01 and GMMW-02.

The OCL was ranked, by USEPA, using the Hazard Ranking System (HRS) in 1985 and was then placed on the NPL on June 10, 1986. Qualitative estimates of potential hazardous constituents placed in the landfill were provided by the PRPs. Waste materials generated by the PRPs that may have been disposed of in the OCL included solvents, acids, lubricants, cutting fluids and the metals that were extracted by the aforementioned list of solvents. Polychlorinated biphenyls (PCBs) containing wastes were purported to have also been disposed of at the site.

Quantitative estimates of potential hazardous constituents in the OCL cannot be accurately reported. The OCL RI Report indicated that metals and inorganic municipal wastes are the major constituents of the landfill material with organic contaminants only present in trace amounts. From the results of the RI it is unlikely a significant amount of organic contaminants are currently present within the OCL.

Since waste disposal records were not kept for the OCL it is not possible to ascertain whether the landfill material can be classified as a RCRA listed hazardous waste in accordance with the definitions contained in 40 CFR 261 (Subpart D). Additionally, information is not available to determine what percentage of the landfill material, if any, can be classified as a RCRA characteristic hazardous waste in accordance with the definitions listed in 40 CFR 261 (Subpart C). Regardless, since placement of the waste material within the OCL occurred prior to the 1980 enactment date of the RCRA regulations, the landfill material, if left in place, does not fall under the classification of a RCRA hazardous waste. If any of the waste material is excavated from the landfill, however, the excavated material would have to be tested to determine if it falls under the classification of a RCRA characteristic hazardous waste. If the excavated material is determined to be a RCRA characteristic hazardous waste, then it would have to be stored, treated, and/or disposed of in accordance with all applicable RCRA requirements.

2.3 SUMMARY OF THE REMEDIAL INVESTIGATION

A remedial investigation was conducted at the OCL site from October 1988 through January 1990. The objectives of the remedial investigation were to assess the direction and rate of ground-water flow in the vicinity of the landfill, characterize the horizontal and vertical extent of any affected ground water, and assess the impact of the waste material deposited in the landfill on soil, ground water, surface water and river sediments in the vicinity of the site. The results of the remedial investigation have been presented in an earlier report (G&M 1990a).

2.3.1 Previous Investigations

Initial site investigation activities at the OCL were conducted in 1982 by Dames & Moore on behalf of Cummins Engine Company (hereafter referred to as Cummins), who were the original notifiers of the site, following the requirements of CERCLA, Section 103. No on-site data collection activities were conducted during this initial investigation; however, a background data review was conducted as part of the investigation and indicated that the site was a potential source of ground-water contaminants. The proximity of the landfill to the City of Columbus municipal well field was also identified in the report as a potential concern. The report, however, did not recommend that additional data collection activities were warranted for the OCL.

In late 1985, Soil & Material Engineers (S&ME) completed a preliminary subsurface investigation of the OCL on behalf of Cummins. The site investigation activities consisted of installing seven monitoring wells (six shallow wells, GMMW01 through GMMW06, completed at the water table and one deep well, GMMW07, completed at the base of the unconsolidated aquifer) along the axis of the landfill and collecting waste, subsurface soil and ground-water samples for laboratory analysis. The seven monitoring wells were retained as sampling points during the present remedial investigation.

Between November 1985 and September 1986 additional ground-water sampling activities were conducted by S&ME on behalf of Cummins. These ground-water samples were collected from the original seven monitoring wells (quarterly sampling). The samples were analyzed for target constituents based on results of the initial round of sampling. The data were not accepted by USEPA for quantitative use in the RI/FS because the quality control and quality assurance procedures used during the sampling and analysis activities had not been approved by the agency or sufficiently documented.

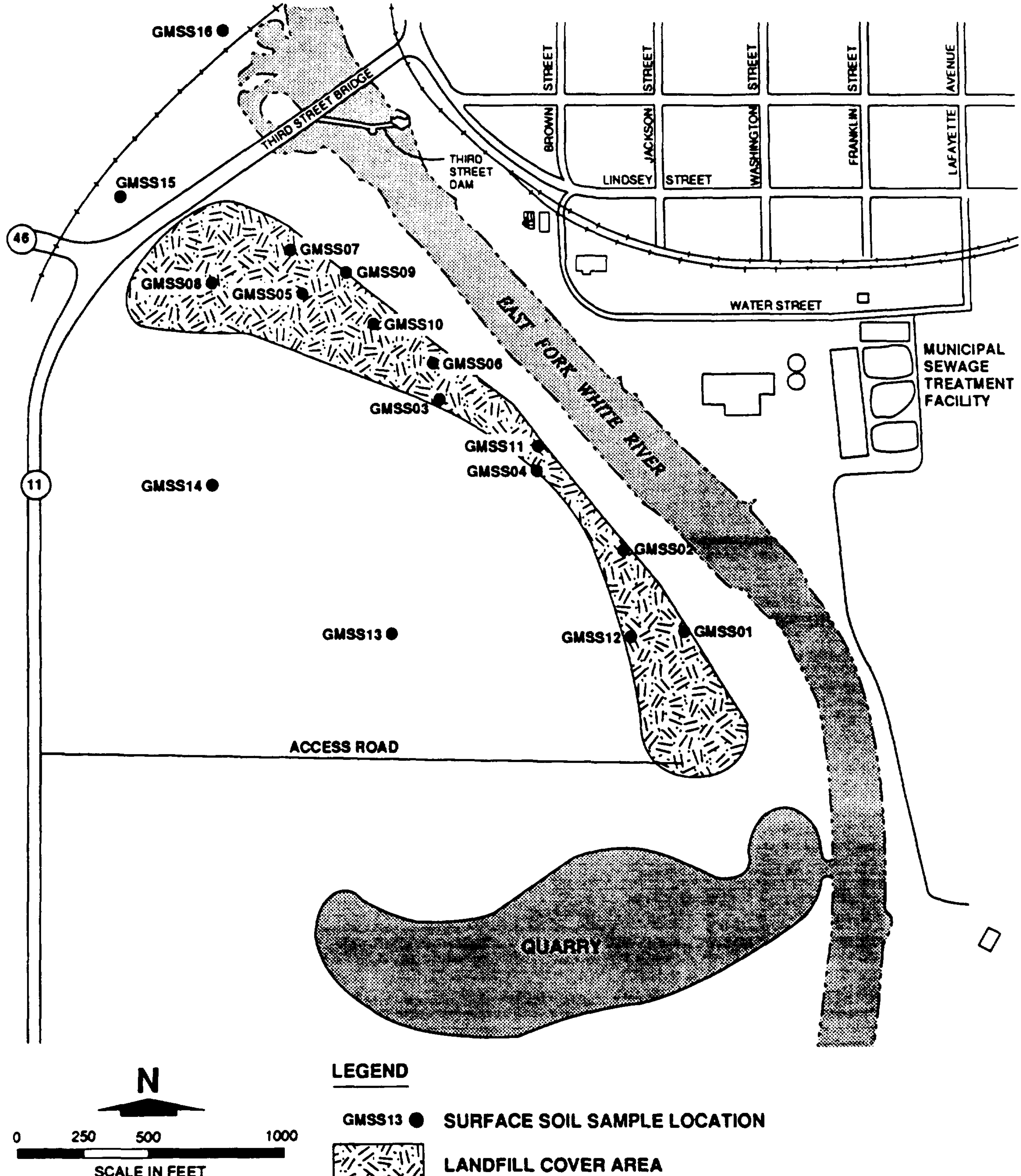
A summary of the field activities performed during the current remedial investigation is presented in the following section.

2.3.2 Remedial Investigation

Environmental samples from the landfill material and surrounding media were collected during the remedial investigation to assess the environmental impact of the landfill operations. Surficial soil, subsurface soil, surface water, river sediment, and landfill waste samples were collected in October and November 1988. Two rounds of ground-water samples were collected in December 1988 and September/October 1989. Each of these sampling activities is described below.

Surficial Soil: A total of 19 surface soil and QA/QC samples were collected from the existing landfill cover during the remedial investigation. The surface soil sampling locations are shown on Figure 2-5. Eight discrete surface soil samples were collected from the landfill cover by establishing a grid and collecting two random samples from each quadrant of the landfill (GMSS01 through GMSS08). Also, one additional sample was collected in each of the four quadrants at locations identified by the USEPA site representative. Background samples were collected at four locations, two west (GMSS13 and GMSS14) and two north (GMSS15 and GMSS16) of the landfill. Three duplicate samples and a field blank and trip blank sample were collected for QA/QC purposes. All of the surficial soil samples were analyzed for the USEPA Target Compound List (TCL) parameters.

Subsurface Soil: Site specific geologic information was obtained from 14 soil borings completed on and in the vicinity of the landfill during October, November and December



LEGEND

GMSS13 ● SURFACE SOIL SAMPLE LOCATION

LANDFILL COVER AREA

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FIGURE 2-5
SURFACE SOIL SAMPLING LOCATIONS
OLD CITY LANDFILL
COLUMBUS, INDIANA

1988. The soil boring locations are shown on Figure 2-6. Five of the soil borings shown on Figure 2-6 were completed as piezometers (GMSB01/P1, GMSB03/P2D, GMSB05/P3, GMB06/P4, GMSB07/P5D). Seven additional soil borings were completed for the purpose of installing monitoring wells (GMMW06 and GMMW08 through GMMW13). The locations of the new monitoring wells along with those of the piezometers are shown in Figure 2-6.

Subsurface samples were collected from six of the borings to evaluate the characteristics of subsurface soil in the area surrounding the landfill. A total of nine subsurface samples were collected for USEPA TCL analysis from six soil borings located outside and adjacent to the landfill area. These nine samples consisted of seven samples collected from the four soil borings on the west side of the landfill (GMSB02, GMSB04, GMSB12, and GMSB14) at depths of approximately 4-10 ft and 12-16 ft below land surface (bls), and two collected from the two soil borings on the east side of the landfill (GMSB06 and GMSB07) at a depth of approximately 2-4 ft bls. Soil samples were not collected for chemical analysis from Soil Borings GMSB01, GMSB03, GMSB05 and GMSB13. Soil Boring GMSB01 was initially intended to be positioned as a background boring, however, waste material was encountered and an additional background boring (GMSB14) was subsequently completed to delineate the northwest edge of the fill area.

Ground Water: Two rounds of ground-water samples were collected from the 13 monitoring wells and submitted for chemical analysis during completion of the remedial investigation. The monitoring well network consisted of the seven existing wells that had been installed by S&ME in 1985 (i.e., designated as GMMW01 through GMMW07), and the six new monitoring wells (GMMW08 through GMMW13) installed by G&M as part of the remedial investigation. The locations of the monitoring wells are shown on Figure 2-7. Twenty-three ground-water samples were submitted for analysis during the initial

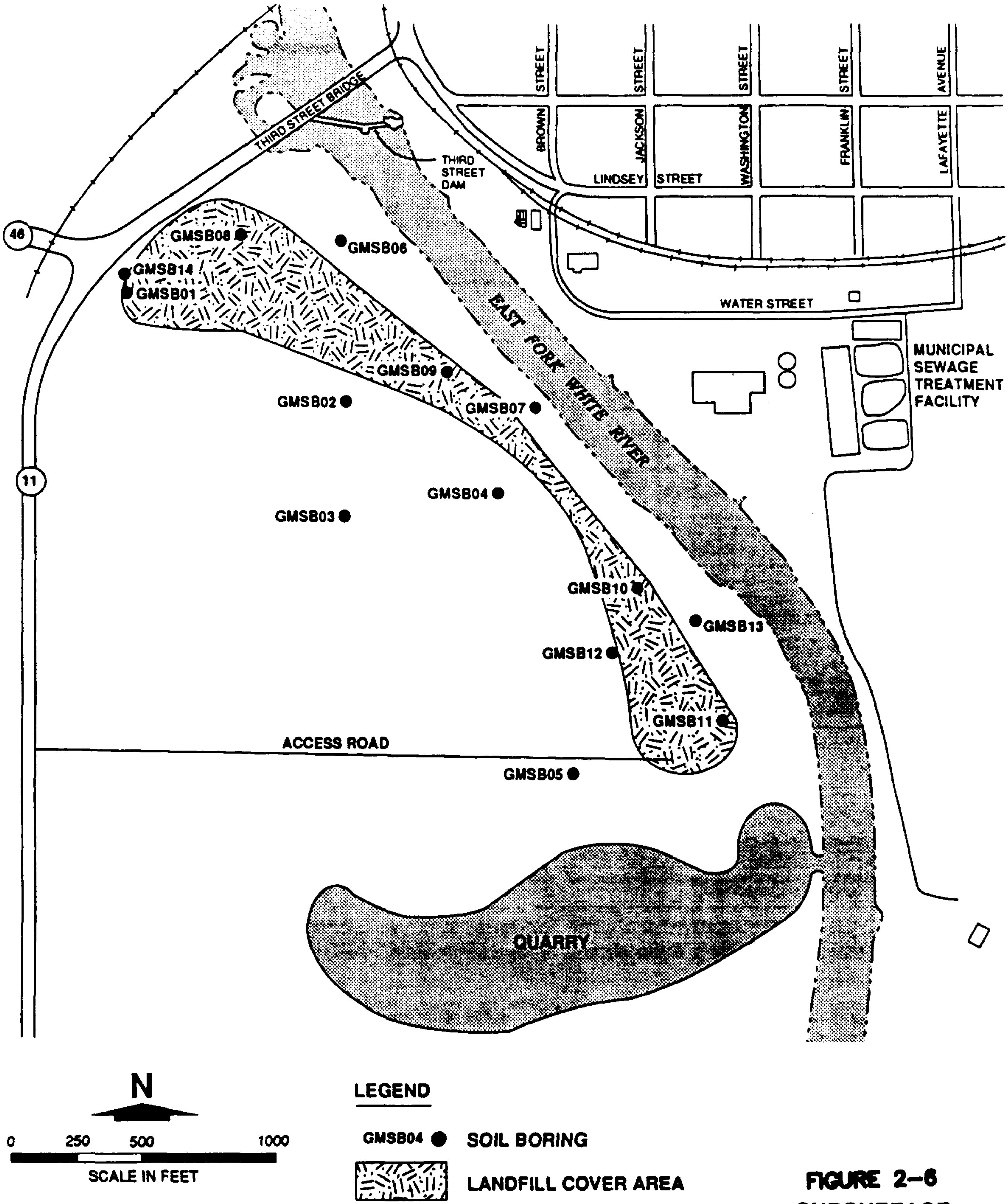

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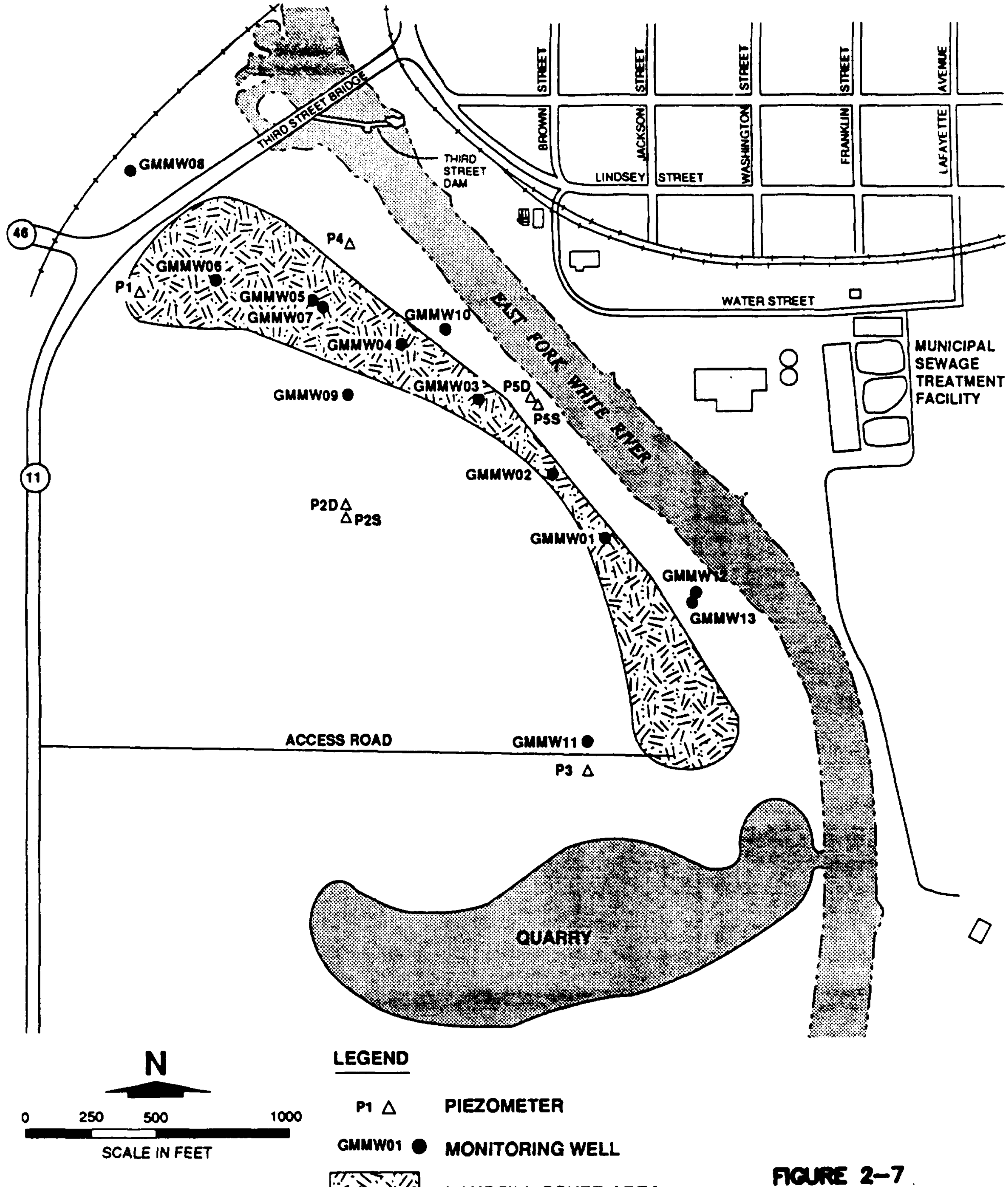
FIGURE 2-6
SUBSURFACE SAMPLING LOCATIONS
OLD CITY LANDFILL
COLUMBUS, INDIANA



LEGEND

P1 △ PIEZOMETER

GMMW01 ● MONITORING WELL

LANDFILL COVER AREA

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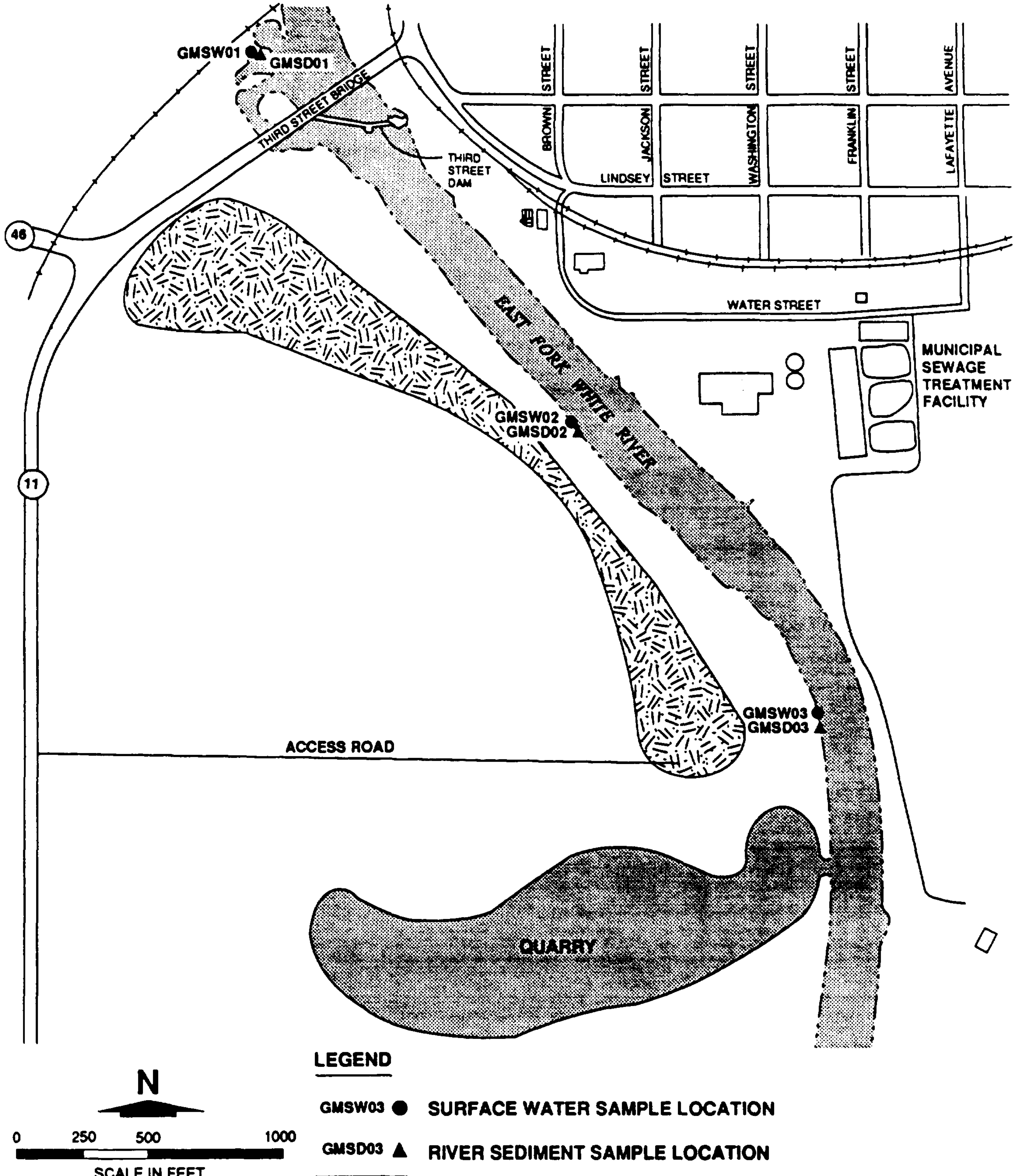
FIGURE 2-7
PIEZOMETER AND MONITORING WELL LOCATIONS
OLD CITY LANDFILL
COLUMBUS, INDIANA

round of sampling, including 13 samples from the monitoring wells, three duplicate samples, three field blanks and four trip blanks. Twenty-two samples were taken during the second round with the same distribution as the first sampling round, with the exception of one less trip blank. Ground-water samples collected during the initial ground-water sampling round were analyzed for USEPA TCL compounds. The ground-water samples collected during the second sampling round were also analyzed for the USEPA TCL constituents with the exception of total metals and cyanide.

Surface Water: Three surface-water samples (GMSW01 through GMSW03) were collected from the East Fork of the White River to evaluate the river water quality upstream, adjacent to and downstream of the landfill. The surface-water sampling locations are shown in Figure 2-8. In addition to the three surface-water samples, one duplicate, one field blank and one trip blank (VOCs) were analyzed for the USEPA TCL constituents.

Sediments: River sediment samples were collected to assess the quality of the river sediments upstream, adjacent to and downstream of the landfill. The locations of the river sediment sampling stations are also shown on Figure 2-8. In addition to the three sediment samples, a duplicate and field blank sample were collected. These samples were analyzed for the USEPA TCL parameters.

Landfill Waste. A total of 11 landfill waste samples were collected from the four soil borings completed in the landfill waste area. This included two samples from each boring, one taken at an approximate depth of 4-10 ft bls and one at an approximate depth of 14-18 ft bls, and three duplicate samples for QA/QC purposes. The samples were analyzed for the USEPA TCL parameters.



LEGEND

GMSW03 ● SURFACE WATER SAMPLE LOCATION

GMSD03 ▲ RIVER SEDIMENT SAMPLE LOCATION

LANDFILL COVER AREA

FIGURE 2-8
SURFACE WATER AND RIVER SEDIMENT SAMPLING LOCATIONS
OLD CITY LANDFILL
COLUMBUS, INDIANA

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Leachate: No evidence of active or inactive seeps were visible; therefore, no samples were collected for analysis.

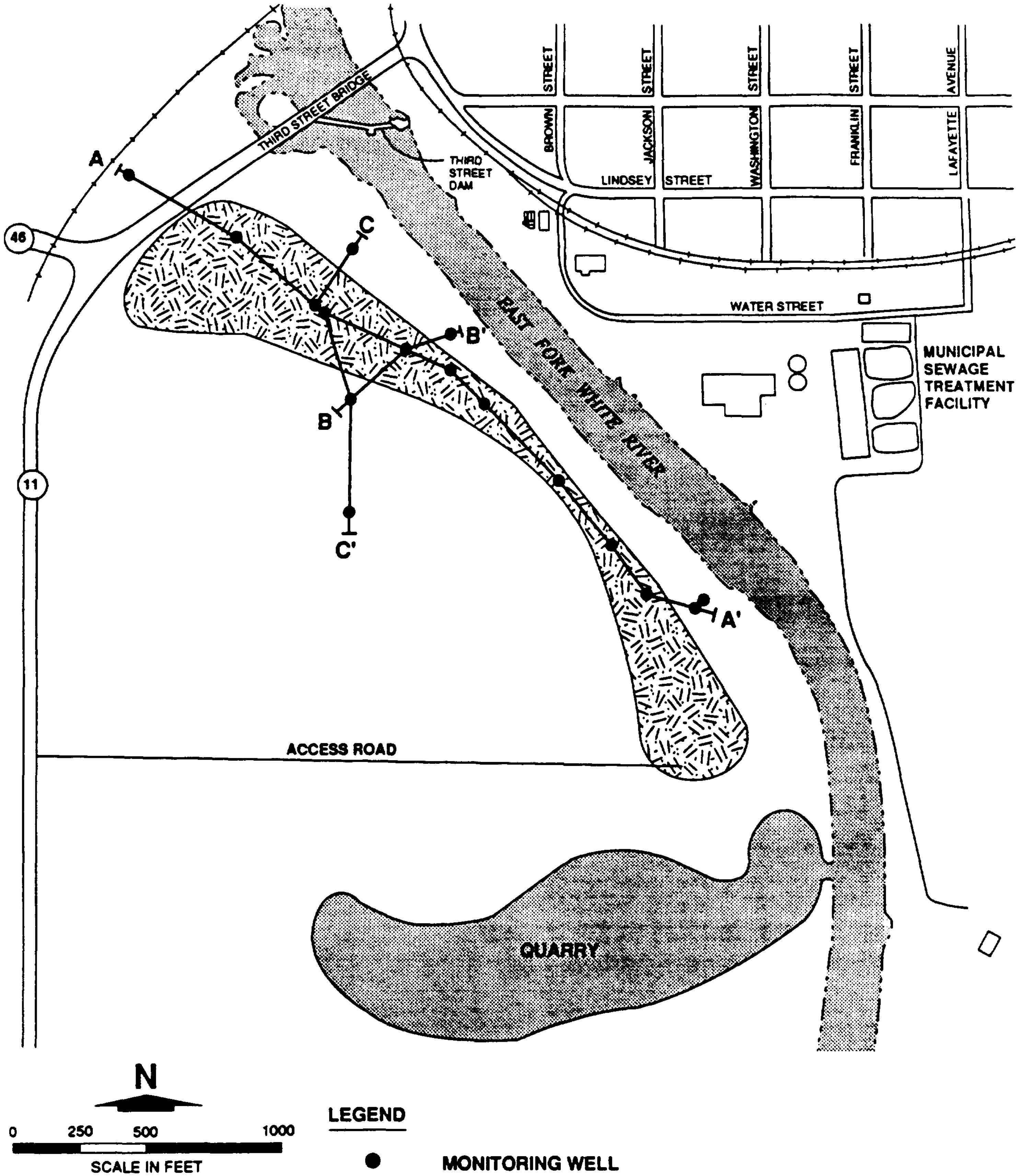
2.3.3 Summary of Physical Analyses

The physical characteristics of the OCL site have previously been described in Section 2.1 of this report. Further elaboration of the physical characteristics of the site is presented in this section, with particular emphasis on the site geology and hydrogeology, as determined from the physical analyses conducted during the remedial investigation. A summary of the chemical analyses conducted during the remedial investigation is presented in Section 2.4.

2.3.3.1 Geology

Information obtained from the soil boring program described in Section 2.3.2 has been used to define the subsurface conditions at the site. The depths of the soil borings ranged from 14 to 47 ft. bls. Continuous split-spoon soil samples were collected from Soil Borings GMSB01 through GMSB14. Continuous soil samples were collected from the soil borings that were completed as monitoring wells. The geologic field logs for each soil boring are contained in Appendix D of the RI report (G&M 1990a).

From the field descriptions contained in these logs, geologic cross sections of the site have been constructed. The geologic cross section locations are shown on the site plan presented in Figure 2-9. Selected geologic cross sections are presented in Figures 2-10 and 2-11. Geologic Section A-A (Figure 2-10) extends along the axis of the landfill. Examination of Cross-Section A-A reveals that the uppermost natural deposit of unconsolidated material at the site consists of coarse sand and gravel-sized material. The sand and gravel deposit extends to



LEGEND

● MONITORING WELL

LANDFILL COVER AREA

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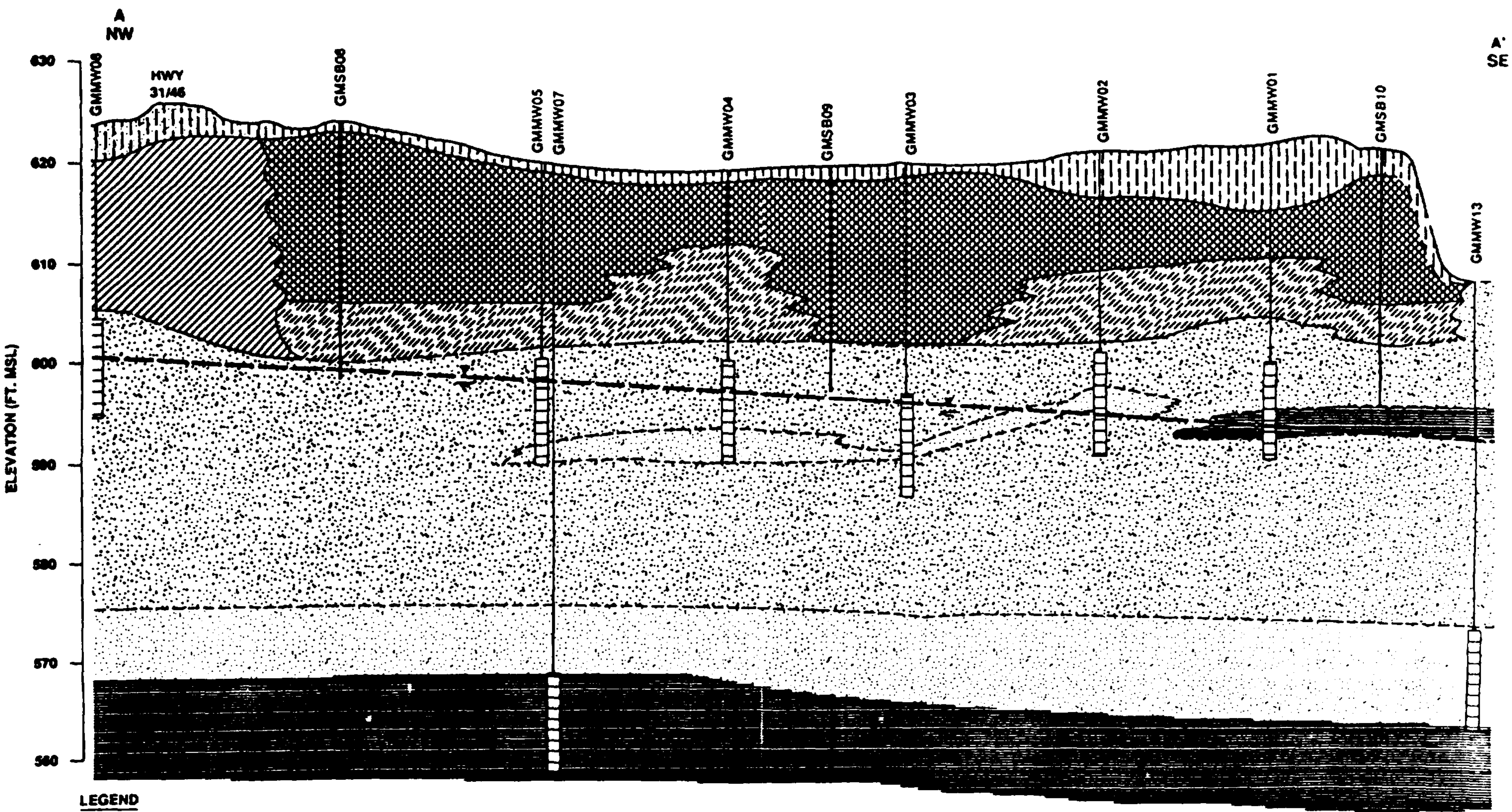
FIGURE 2-9
GEOLOGIC CROSS SECTION LOCATIONS
OLD CITY LANDFILL
COLUMBUS, INDIANA



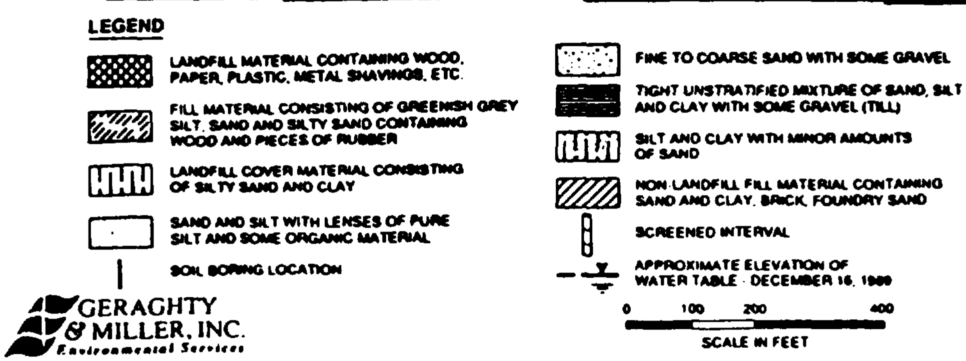


FIGURE 2–10
GEOLOGIC SECTION A-A'
OLD CITY LANDFILL
COLUMBUS, INDIANA

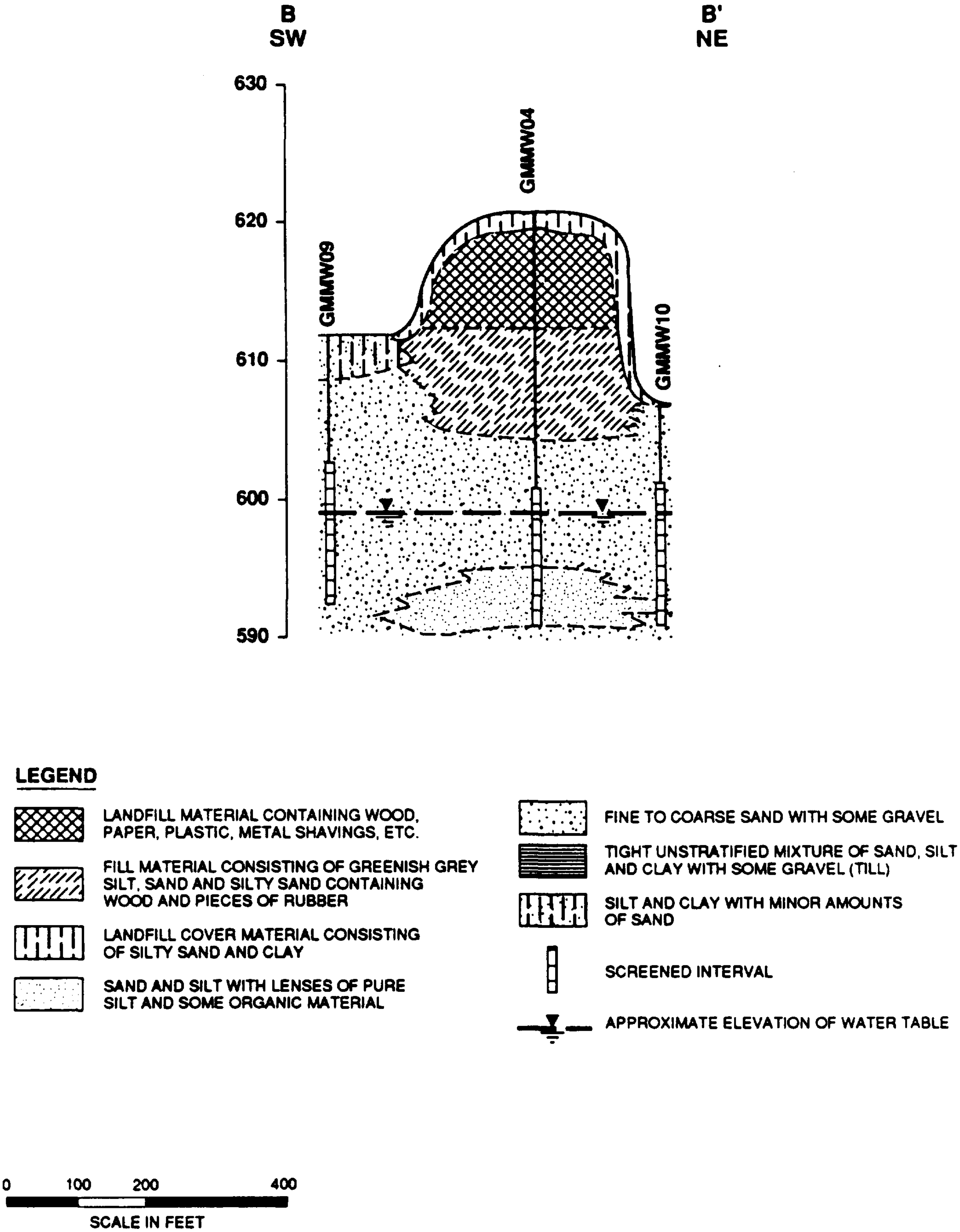


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FIGURE 2-11
GEOLOGIC SECTION B-B'
OLD CITY LANDFILL
COLUMBUS, INDIANA

a depth of approximately 15 ft. below the natural land surface as observed at location GMMW13. Underlying the sand and gravel deposit is an intermittent thin sandy clay and gravel zone (glacial till) approximately 2 to 3 ft. thick. The thin till zone is underlain by a very coarse sand and gravel deposit which is approximately 15 ft thick. This sand and gravel deposit was found to be continuous across the site. At a depth of approximately 30 to 35 ft bls (Elevation 580-575 ft.), silts and clays containing organic material become prominent. Lenses and thin beds of very fine to coarse grained sand containing silt are mixed throughout this zone. Underlying the silt and clay zone is a firm deposit of silt and clay mixed with pebbles (glacial till). This deeper till deposit lies at a depth of approximately 40 to 45 ft bls. (Elevation 570-565 ft.). Based on the soil borings completed in 1968 (by ATEC Associates) for the City of Columbus, this till unit is believed to extend to the shale bedrock interface.

The base of the landfill waste material is irregularly shaped. The minimum depths at which the bottom of the landfill material was noted were Elevations 610 ft. and 613 ft. at GMMW01, GMMW02 and GMMW04. The observed thickness of the landfill material at these locations is approximately ten feet. The depth of the landfill material in this area is further illustrated in Figure 2-11.

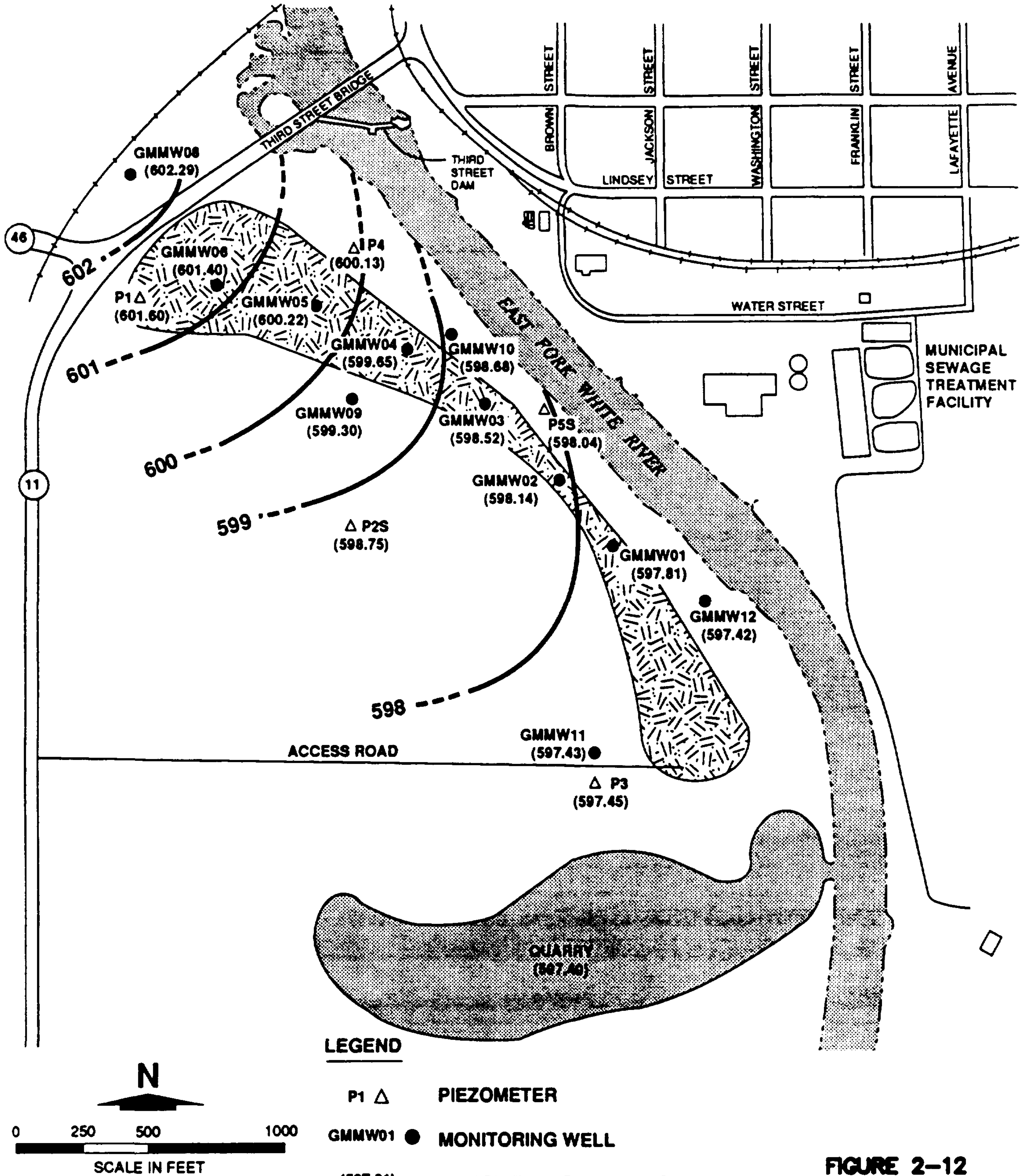
The maximum depth at which the bottom of the landfill material was noted was Elevation 602 ft. in the central portion of the site at Soil Boring GMSB09. The thickness of the landfill material in this area is approximately 20 ft. The bottom of the landfill material is above the observed elevation of the water table.

The existence of a non-landfill fill material (containing sand and clay, brick, and foundry sand) at the northwest boundary of the OCL was observed during the remedial investigation. The delineation between the landfill material and the non-landfill fill material northwest of Soil Boring GMSB08 is shown on Figure 2-10. Based on the lateral extent of the waste material observed during completion of the soil borings and information obtained from the detailed topographic map, the area occupied by the landfill waste material is estimated to be 19 acres.

2.3.3.2 Hydrogeology

Water level elevation data collected in December, 1988 has been used to construct the water table map shown on Figure 2-12. It should be noted that Monitoring Wells GMMW07 and GMMW13 are not shown on Figure 2-12 because they are deep wells and, thus, do not provide data concerning the elevation of water table. The ground-water flow direction is generally to the south-southeast. Depth to ground water in the OCL area is approximately 5 to 15 ft. bls. At the landfill, where the fill operations have raised the elevation of the land surface, the depth to ground water varies from 15 to 25 ft. below the surface of the landfill. The gravel quarry, located near the southeast corner of the OCL, and the East Fork of the White River both function as discharge points for the ground water that passes through the shallow aquifer beneath the site. The RI concluded that water table elevation fluctuations have generally not altered the ground-water flow direction and horizontal hydraulic gradients, except for the areas near the river and the quarry (G&M 1990a).

Hydraulic conductivities determined from slug tests performed on monitoring wells at the site ranged from 5×10^{-3} cm/sec to 3.4×10^{-2} cm/sec, with an arithmetic mean of approximately 2.2×10^{-2} cm/sec. Based on the average hydraulic conductivity and the observed hydraulic gradient (0.001 to 0.003 ft/ft) the average linear ground-water flow velocity is estimated to be approximately 90 ft/yr in the southern area of the landfill and 270 ft/yr in the northern area of the landfill.



LEGEND

P1 △	PIEZOMETER
GMMW01 ●	MONITORING WELL
(597.81)	WATER TABLE ELEVATION
	LANDFILL COVER AREA
599	WATER TABLE CONTOUR (Dashed Where Inferred)

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FIGURE 2-12
WATER TABLE CONTOUR MAP
DECEMBER 16, 1988
OLD CITY LANDFILL
COLUMBUS, INDIANA

2.4 NATURE AND EXTENT OF CONTAMINATION

A summary of the field sampling and chemical analyses performed during the remedial investigation is presented in this section. All samples collected from the OCL area were analyzed for USEPA TCL constituents. The RI sample analyses are summarized in this section for each of the environmental media potentially impacted by the OCL. For a more comprehensive presentation of the sample analyses, the reader is referred to the Remedial Investigation Final Report prepared by G&M, dated July, 1990. Tables 2-1 through 2-6 included in this document are reproductions of Tables 32 through 37 from the RI report. These tables are presented in this document as a means for summarizing the occurrence of constituents detected in the ground water, surface soil, subsurface soil, landfill material, surface water and river sediments at the OCL site.

2.4.1 Air

During completion of the field investigation activities, monitoring of the air was performed to provide qualitative information only, regarding the relative concentrations of photoionizable volatile organic compounds (VOCs) for the purpose of field screening environmental samples, and selecting appropriate levels of protection for field personnel. Air monitoring was conducted in the area near the drilling equipment with particular attention focused near the auger/borehole interface and within the breathing zone of the drilling personnel. An HNu™ photoionization meter was used to perform the monitoring.

2.4.2 Surficial Soil

Evaluation of the VOC analyses indicates that chloroform and methyl ethyl ketone were detected on one occasion in separate samples, at concentrations of 23.0 ug/kg and 10.0 ug/kg,

Table 2-1. Occurrence of Constituents in Surficial Soil at the Old City Landfill, Columbus, Indiana

Constituent	Range [a]	Average Detected Concentration [b]	Frequency of Detection [c]	Background Range
Metals				
Aluminum	3,800-7,610	6388	12/12	7,410-16,500
Antimony	3.4-9.6	6.12	6/12	6.3-8.4
Arsenic	3.2-6.9	4.39	12/12	5.0-7.0
Barium	20-120	70.3	12/12	73-180
Beryllium	0.18-0.55	0.34	12/12	0.33-0.82
Cadmium	0.13-2.6	0.65	12/12	0.37-0.97
Calcium	31,500-126,000	53058	12/12	4,100-62,900
Chromium	7.9-35	13.03	12/12	12-32
Cobalt	3.3-6.7	4.89	12/12	5.3-11
Copper	7.1-67	18	12/12	12-29
Iron	9,590-21,400	14216	12/12	15,200-28,700
Lead	7.4-92	33	12/12	2-54
Magnesium	10,700-34,600	18350	12/12	4,050-23,900
Manganese	263-833	468	12/12	546-1,310
Mercury	0.05-0.47	0.10	12/12	0.061-0.096
Nickel	2.1-43	21.1	12/12	13-60
Potassium	540-1,300	933	12/12	1,100-2,400
Silver	0.57-0.76	0.65	4/12	BDL-0.93
Sodium	52-140	83.3	12/12	41-110
Vanadium	11-22	16.4	12/12	21-37
Zinc	28-180	74.1	12/12	58-110
Volatile Organics				
Chloroform	0.023	0.023	1/12	BDL
Dichlorobromo-methane [d]	0.0048	0.0048	1/12	BDL
2-Hexanone [d]	0.0058	0.0058	1/12	BDL
Methyl ethyl ketone [d]	0.01	0.01	1/12	BDL
M-xylene [d]	0.002	0.002	1/12	BDL
Semi-Volatile Organics [d]				
Diethyl phthalate	0.04-0.06	0.05	4/12	0.043-0.063
Di-n-butylphthalate	0.04-0.05	0.05	2/12	0.055
Fluoranthene	0.03-0.49	0.21	6/12	0.056-0.077
Pyrene	0.03-0.39	0.18	6/12	0.069
Chrysene	0.07-0.11	0.09	2/12	BDL
Bis(2-ethylhexyl)phthalate	0.06-0.41	0.17	4/12	0.2-0.3
Di-N-octylphthalate	0.07	0.07	1/12	BDL
Benzo(b)fluoranthene	0.02-0.18	0.11	4/12	BDL
Benzo(a)pyrene	0.09	0.09	1/12	BDL
Indeno(1,2,3-c,d)pyrene	0.08	0.08	1/12	BDL
Benzo(g,h,i)perylene	0.09	0.09	1/12	BDL
Miscellaneous				
Cyanide (total)	0.00061-0.00078	0.00068	3/12	0.00091

Concentrations reported in milligrams per kilogram (mg/kg).

BDL = Below Detection Limit.

[a] = Minimum - Maximum Concentrations.

[b] = Average is based upon those data points reported as above Detection Limit.

[c] = x/y; where x = number of samples with analytical results above the detection limit and y = number of samples analyzed.

[d] = Estimated concentration; all semi-volatile compound concentrations are estimated values.

Table 2-2. Occurrence of Constituents in Subsurface Soil at the Old City Landfill, Columbus, Indiana

Constituent	*Range [a]*	*Average Detected Concentration [b]*	*Frequency of Detection [c]*	*Background Range [d]*
Metals				
Aluminum	1,300-3,250	2247	7/7	8,810-12,900
Antimony	2.2-5.3	3.8	7/7	BDL
Arsenic	2.0-5.2	3.1	7/7	5.4-9.9
Barium	8.3-180	47.0	7/7	85-120
Beryllium	0.055-0.28	0.12	7/7	0.29-0.47
Cadmium	0.091-1.6	0.85	2/7	BDL
Calcium	41,200-176,000	97314	7/7	44,200-44,900
Chromium	3.1-49	12	7/7	11-14
Cobalt	1.8-3.6	2.6	6/7	6.4-7.8
Copper	3.4-348	55	7/7	12-17
Iron	5,780-14,900	8388	7/7	16,600-24,400
Lead	1.8-210	33	7/7	12-17
Magnesium	1,920-43,500	24517	7/7	16,000-19,700
Manganese	196-445	290	7/7	570-934
Mercury	0.018-0.24	0.067	5/7	BDL
Nickel	3.6-36	9.7	7/7	13-20
Potassium	120-590	281	7/7	670-800
Silver	0.27-1.9	0.92	4/7	BDL
Sodium	44-93	63.3	7/7	BDL
Vanadium	4.5-16	8.3	7/7	19-26
Zinc	9.8-340	63	7/7	53-74
Cyanide (total)	0.00059-0.00085	0.00069	6/7	BDL
Volatile Organics				
Methyl Ethyl Ketone [e]	0.023	0.023	1/7	BDL
Base/Neutral and Acid Compounds				
Acenaphthene	0.032	0.032	1/7	BDL
Benzo(a)anthracene	0.053	0.053	1/7	BDL
Benzo(a)pyrene	0.36	0.36	1/7	BDL
Benzo(b)fluoranthene	0.45	0.45	1/7	BDL
Benzo(g,h,i)perylene	0.69	0.69	1/7	BDL
Benzo(k)fluoranthene	0.41	0.41	1/7	BDL
Chrysene	0.43	0.43	1/7	BDL
1,4-Dichlorobenzene	0.039	0.039	1/7	BDL
Fluoranthene	0.54	0.54	1/7	BDL
Fluorene	0.021	0.021	1/7	BDL
Indeno(1,2,3-c,d)-pyrene	0.3	0.30	1/7	BDL
Naphthalene	0.022	0.022	1/7	BDL
N-Nitrosodi-N-propyla	0.025	0.025	1/7	BDL
Phenanthrene	0.28	0.28	1/7	BDL
Pyrene	0.44	0.44	1/7	BDL
1,2,4-Trichloro-benzene	0.021	0.021	1/7	BDL
Dibenzofuran	0.012	0.012	1/7	BDL
Diethyl phthalate	0.030	0.030	1/7	0.030
2-Chlorophenol	0.048	0.048	1/7	0.04
Pesticides and PCBs				
Delta-BHC [e]	0.03	0.03	1/7	BDL

Concentrations reported in milligrams per kilogram (mg/kg).
BDL = Below Detection Limit.
[a] = Minimum - Maximum concentrations.
[b] = Average is based upon those data points reported as above Detection Limit.
[c] = x/y; where x = number of samples with analytical results above Detection Limit and y = number of samples analyzed.
[d] = Average range of two samples (GMSB14-03 and GMSB14-08) collected from depths of 4-6 and 14-16 feet.
[e] = Estimated concentration.

Table 2-3. Occurrence of Constituents in Ground Water at the Old City Landfill, Columbus, Indiana

Constituent	*Range [a]*	*Average Detected Concentration [b]*	*Background Range*	*MCLs [c]*	
Metals					
Aluminum	0.02[d]-0.16	0.030	0.073-1.32	0.05-0.2	[PS]
Arsenic	0.0004[d]-0.016	0.0026	0.0009	-	
Barium	0.078-0.58	0.21	0.10	5.00	
Beryllium	0.00020[d]-0.0004	0.00023	BDL	0.001	[P]
Cadmium	0.00075[d]-0.0032	0.0011	BDL	0.005	
Calcium	86.4-165	120	109-112	-	
Chromium	0.0029[d]-0.0058	0.0031	BDL	1.0	
Copper	0.0018[d]-0.012	0.003	BDL	1.3	
Lead	0.0006[d]-0.0099	0.002	0.0037-0.0083	0.005	
Magnesium	21-49	3.3	27.4-27.9	-	
Manganese	0.00075[d]-0.89	0.31	0.258-0.944	0.05	[S]
Nickel	0.0019[d]-0.0063	0.0028	BDL	1.0	
Potassium	0.65-34.6	9	1.7-1.9	-	
Selenium	0.00035[d]-0.0018	0.0049	BDL	0.05	
Silver	-	-	BDL	0.09	[PS]
Sodium	2.1-3.5	19	8.2-12	-	
Thallium	-	-	BDL	0.002	[P]
Vanadium	0.0027[d]-0.001	0.0039	BDL	-	
Zinc	0.0015[d]-0.31	0.076	0.0054-0.068	5.0	[S]
Organic Compounds					
Bis(2-ethylhexyl) phthalate [e]	0.0020-2.3	0.0061	BDL	-	
Acenaphthylene	-	-	BDL	-	
2,4-dimethylphenol	-	-	BDL	-	
1,2-dichloroethane	-	-	BDL	0.005	
Methyl ethyl ketone	-	-	BDL	-	
2-methylnapththale	-	-	BDL	-	
Napthalene	-	-	BDL	-	
Toluene	-	-	BDL	2.0	
Miscellaneous					
Chloride	21-56	33	24.6-31.8	250	[S]
Nitrate	0.05[d]-10.8	2.4	7.6	10.0	
Sulfate	26-60	41	43-67	250	[S]

Concentrations reported in milligrams per liter (mg/L).
BDL = Below Instrument Detection Limit.
"-" Indicates constituent detected only once or MCL not currently established.
[a] = Minimum-Maximum concentrations.
[b] = Average utilizes 50% of method Detection Limit for data points reported below quantitation limit.
[c] = Maximum contaminant levels for drinking water (USEPA April 1990)
[d] = Value is one-half of instrument Detection Limit.
[e] = Average was calculated geometrically due to an extreme outlier concentration.
[S] = Secondary Maximum Contaminant Level
[P] = Proposed Maximum Contaminant Level
[PS] = Proposed Secondary Maximum Contaminant Level

Table 2-4. Occurrence of Constituents in Surface Water from the East Fork of the White River, Columbus, Indiana

Constituent	*Range [a]*	*Average Detected Concentration [b]*	*Frequency of Detection [c]*	*Site-Specific Background [d]*
Metals				
Aluminum	0.057-0.058	0.058	2/2	0.047
Barium	0.074-0.081	0.078	2/2	0.074
Calcium	84.2-86.2	85.2	2/2	85.5
Copper	0.0052-0.0056	0.0054	2/2	0.0039
Iron	0.16-0.17	0.17	2/2	0.13
Magnesium	28.9-29.5	29.2	2/2	29.5
Manganese	0.020-0.035	0.028	2/2	0.02
Potassium	1.9-2.0	2.0	2/2	1.8
Sodium	26.0-29.0	27.5	2/2	27.0
Zinc	0.0072-0.0075	0.0074	2/2	0.012
Organics				
Bis(2-ethylhexyl) phthalate	0.00087-0.0018	0.0016	2/2	0.0012

Concentrations reported in milligrams per liter (mg/L).

[a] = Minimum-Maximum concentrations.

[b] = Average is based upon those data points reported as above detection limit.

[c] = x/y; where x = number of samples with analtyical results above the detection limit and y = number of samples analyzed.

[d] = From upstream sample (I.D. GMSS01).

Table 2-5. Occurrence of Constituents in Sediment from the East Fork of the White River, Columbus, Indiana.

Constituent	*Range [a]*	*Average Detected Concentration [b]*	*Frequency of Detection [c]*	*Site-Specific Background [d]*
Metals				
Aluminum	1,500-1,600	1550	2/2	1600
Antimony	3.5-4.7	4.1	2/2	BDL
Arsenic	1.8	1.8	2/2	1.8
Barium	13-16	14.5	2/2	13
Beryllium	0.19	0.19	1/2	0.19
Cadmium	0.16	0.16	1/2	0.11
Calcium	108,000-128,000	18000	2/2	64700
Chromium	4.2-5.2	4.7	2/2	5.8
Cobalt	1.4	1.4	2/2	BDL
Copper	3.7-4.4	4.1	2/2	2.6
Iron	5,150-6,110	5630	2/2	4400
Lead	2.3-10	6.2	2/2	2.6
Magnesium	36,800-37,500	37150	2/2	18300
Manganese	216-324	270	2/2	152
Mercury	BDL	BDL	0/2	0.042
Nickel	4.2-4.4	4.3	2/2	4.9
Potassium	210-250	230	2/2	290
Silver	0.81	0.81	1/2	BDL
Sodium	76-130	103	2/2	110
Vanadium	7.2-8.8	8	2/2	5.6
Zinc	14-16	15	2/2	18
Base/Neutral and Acid Compounds				
Bis(2-ethylhexyl) phthalate [e]	0.11-0.68	0.39	2/2	BDL
2,4,6-Trichloro-phenol [e]	0.12	0.12	1/2	BDL
Miscellaneous				
Cyanide (total)	0.0008	0.0008	1/2	BDL

Concentrations reported in milligrams per kilogram (mg/kg).

BDL = Below Detection Limit.

[a] = Minimum-Maximum concentrations.

[b] = Average is based upon those data points reported as above Detection Limit.

[c] = x/y; where x = number of samples with analytical results above the detection limit and y = number of samples analyzed.

[d] = From upstream sample (I.D. GMSD01).

[e] = Estimated concentration(s).

Table 2-6. Occurrence of Constituents in Landfill Samples at the Old City Landfill, Columbus, Indiana.

Constituent	*Range [a]*	*Average Detected Concentration [b]*	*Frequency of Detection [c]*
Metals			
Aluminum	1,300-8,390	4788	8/8
Antimony	3.20-23.0	11	4/8
Arsenic	1.90-9.40	5.01	8/8
Barium	19.0-1,580	288.0	8/8
Beryllium	0.06-0.52	0.23	8/8
Cadmium	0.14-24.0	6.94	6/8
Calcium	48,800-164,000	102675	8/8
Chromium	4.70-3,250	431	8/8
Cobalt	1.20-49.0	9.53	7/8
Copper	5.30-220	86.7	8/8
Iron	5,240-61,000	31630	8/8
Lead	1.80-7,610	1216	8/8
Magnesium	9,620-38,000	22388	8/8
Manganese	320-1,510	605	8/8
Mercury	0.03-0.36	0.17	7/8
Nickel	4.4-95	39.2	8/8
Potassium	210-1,500	885	8/8
Silver	0.67-29.0	12.52	4/8
Sodium	81.0-380	202	8/8
Vanadium	5.7-19.0	13.14	8/8
Zinc	14.0-3370	912	8/8
Cyanide (total)	0.00064-0.0018	0.0009	8/8
Volatile Organics			
Ethylbenzene	0.003-0.02	0.01	2/8
Toluene	0.001-0.0014	0.0012	1/8
Methyl ethyl ketone	0.01-0.03	0.02	2/8
Methyl-iso-butyl ketone	0.07	0.07	1/8
M-xylene	0.0061-0.05	0.03	2/8
O+P-xylenes	0.0069-0.06	0.04	2/8

see notes next page

Page 1 of 2

Table 2-6. Occurrence of Constituents in Landfill Samples at the Old City Landfill Columbus, Indiana (continued).

Constituent	*Range [a]*	*Average Detected Concentration [b]*	*Frequency of Detection [c]*
Base/Neutral and Acid Compounds			
Acenaphthene	0.11-2.52	1.22	4/8
Anthracene	1.79	1.79	1/8
Benzo(a)anthracene	0.13-1.75	0.69	3/8
Benzo(a)pyrene	0.58	0.58	1/8
Benzo(b)fluoranthene	0.14-0.46	0.3	2/8
Benzo(g,h,i)perylene	0.08-0.92	0.5	2/8
Benzo(k)fluoranthene	0.45	0.45	1/8
Chrysene	0.10-1.24	0.65	3/8
Dibenzo(a,h)anthracene	0.19	0.19	1/8
Di-N-butyl phthalate	7.63	7.63	1/8
Fluoranthene	0.19-4.89	2.39	5/8
Fluorene	0.13-2.10	0.86	5/8
Indeno(1,2,3-c,d)-pyrene	0.35	0.35	1/8
Naphthalene	0.08-8.15	3.12	5/8
Phenanthrene	0.62-6.7	3.03	5/8
Pyrene	0.22-3.56	1.71	5/8
2-Methylnaphthalene	0.07-2.33	1.19	5/8
Dibenzofuran	0.07-1.62	0.65	5/8
Pesticides and PCBs			
Beta-BHC	0.29	0.29	1/8
Delta-BHC	0.02	0.02	1/8
4,4'-DDD [e]	0.05-0.06	0.06	2/8
Heptachlor	0.013	0.013	1/8
Alpha-Chlordane	0.09	0.09	1/8
Gamma-Chlordane	0.09	0.09	1/8
Aroclor 1254 [e]	0.84	0.84	1/8

Concentrations reported in milligrams per kilogram (mg/kg).

[a] = Minimum - Maximum Concentrations.

[b] = Average is based upon those data points reported as above Detection Limit.

[c] = x/y; where x = number of samples with analytical results above the detection limit and y = number of samples analyzed.

[d] = Average of two samples (GMSB14-03 and GMSB14-08) collected from depths of 4-6 and 14-16 feet.

[e] = Estimated concentrations.

respectively. All other VOCs analyzed for were below the minimum detection limits (MDLs) for the analytical method used. All semi-volatile compounds analyzed for were below MDLs. Estimated values for several semi-volatile compounds that were identified at concentrations below the MDLs are presented in Table 2-1. No TCL pesticides or PCBs were detected.

Cadmium and mercury were the only inorganics detected above background soil levels. The inorganic analyses identified two elements, cadmium and mercury, in all samples, excluding GMFBSS-01, at maximum concentrations of 2.6 mg/kg and 0.47 mg/kg, respectively. Refer to Table 2-1 for the occurrence of constituents in the surficial soil samples.

2.4.3 Subsurface Soil

Evaluation of the VOC analyses indicates that three compounds (acetone, methylene chloride and methyl ethyl ketone) were detected at concentrations above their MDLs in several of the subsurface soil samples. The maximum detected concentrations of acetone and methylene chloride were 134 ug/kg and 17.6 ug/kg, respectively; however, acetone and methylene chloride were also detected in the field and trip blanks indicating these compounds are likely laboratory contaminants. Methyl ethyl ketone was detected in one subsurface soil sample at an estimated maximum concentration of 23.8 ug/kg. Evaluation of the semi-volatile analyses indicate that no concentrations of compounds were detected above the MDLs. The only detectable pesticide/PCB compound was delta-BHC occurring in subsurface soil sample GMSB07-02 at an estimated concentration of 30 ug/kg. The inorganic analyses indicates maximum concentrations of cadmium (1.6 mg/kg), zinc (340 mg/kg), copper (348 mg/kg) and lead (210 mg/kg) which exceed the background subsurface sample concentrations. Refer to Table 2-2 for the occurrence of constituents in the subsurface soil samples. Note that because they are likely laboratory contaminants, acetone and methylene chloride are not listed as part of Table 2-2.

2.4.4 Ground Water

The ground-water samples collected from the 13 on-site monitoring wells did not exhibit any VOCs above the MDLs. The semi-volatile analyses indicated that four compounds were detected above MDLs during the two ground-water sampling rounds. Concentrations above the MDLs of 2,4-dimethyphenol (23.3 ug/L), napthalene (110 ug/L), and 2-methylnapthalene (6.63 ug/L) were detected in a single ground-water sample during the first round. During the second round of ground-water samples bis(2-ethyhexyl) phthalate was detected above the MDL in one sample at a concentration of 2.3 mg/l. No TCL pesticides or PCBs were detected. Seventeen inorganic elements were detected in at least two ground-water samples including cadmium and lead at maximum concentrations of 3.2 ug/l and 9.9 ug/l respectively. Ground-water indicator parameters were also analyzed to assist in characterizing ground-water conditions at the site. Because no distinct plume of TCL constituents has been identified to be emanating from the landfill area, ground-water indicator parameters were monitored to assist with the assessment of ground-water transport from the site. The ground-water indicator parameters measured for included chloride, nitrate and sulfate. Refer to Table 2-3 for the occurrence of constituents in the ground-water samples. Note that the range and average detected concentration values are not indicated in Table 2-3 for the constituents detected in only a single ground-water sample.

2.4.5 Surface Water

Evaluation of the VOC analyses indicates that methylene chloride and acetone were detected, although these compounds were also detected in the field and trip blank samples. Bis(2-ethylhexyl) phthalate was detected at a maximum concentration of 1.8 ug/L; however, it was also detected upstream of the landfill at a concentration of 1.2 ug/L. There were no semi-volatile compounds detected above the MDLs in the three surface water samples and in the duplicate and field blank samples. No TCL pesticides or PCBs were detected.

The inorganic analyses results identified 10 elements with concentrations above the MDL. Of these 10 elements only lead, which was detected in only one sample at 1.1 ug/l, has a federal standard for ambient water quality, which is 3.2 ug/l. Refer to Table 2-4 for the occurrence of constituents in the surface water samples. Acetone and methylene chloride are not listed on Table 2-4 because they are likely laboratory contaminants.

2.4.6 River Sediment

There were no concentrations of VOCs or semi-volatiles detected above the MDLs in the river sediment samples. However, estimated concentrations (below MDLs) of bis(2-ethylhexyl) phthalate (maximum concentration of 0.68 mg/kg) and 2,4,6-trichlorophenol (0.12 mg/kg) were detected. In addition, no TCL pesticides or PCBs were detected and the inorganic analytical results indicated that the detected element concentrations were not excessive relative to the background levels. Refer to Table 2-5 for the occurrence of constituents in the river sediment samples.

2.4.7 Landfill Waste Material

The VOC constituents detected in the waste material samples include benzene, ethylbenzene, methylene chloride, toluene, acetone, carbon disulfide, methyl ethyl ketone, methyl isobutyl ketone, and xylene. Semi-volatiles (flouranthene 4.9 mg/kg, phenanthrene 6.7 mg/kg, pyrene 3.6 mg/kg, napthalene 8.2 mg/kg, and 2-methylnapthalene 2.3 mg/kg) were detected above the MDL in three of the eight waste samples. Pesticides and PCBs detected include 4,4'-DDD (estimated concentration 57 ug/kg), alpha-chlordane (maximum concentration of 93 ug/kg), and Arochlor 1254 (estimated concentration of 0.84 mg/kg).

The inorganic analyses indicated the presence of a majority of the TCL elements at moderate concentrations including cadmium (24 mg/kg), nickel (95 mg/kg), mercury (0.36 mg/kg), and lead (estimated at 21,700 mg/kg). The upper areas, relative to depth, of the landfill waste material generally contained the highest concentrations of the detected elements. Refer to Table 2-6 for the occurrence of constituents in the landfill samples.

2.5 EXPOSURE PATHWAYS AND RECEPTORS

There are no identified exposed populations or wells impacted by contaminants released from the landfill. The results of the RI concluded that the environmental media of potential concern at the site (i.e., air, surficial soil, ground water and surface water) have not been adversely impacted by the OCL. As a result, the only current potential exposure pathway is the ingestion of and direct contact with the landfill soil cover and waste material. Potential future exposure pathways are direct contact and incidental ingestion of surficial soils on-site by hikers or future construction workers, swimming or ingestion of fish caught locally in the East Fork of the White River or the quarry, and ingestion of water from a hypothetical potable well installed downgradient of the site.

Potential current exposure to the surficial soils was estimated to be within acceptable health-based guidelines for hikers/trespassers or future (hypothetical) construction workers. Hypothetical future exposure to surface water (via swimming and fish ingestion), based on a conservative worst-case assumption, was estimated to result in acceptable risk levels. Hypothetical future use of the ground water as a potable source (assuming current concentrations at off-site downgradient wells) would not pose any unacceptable risks to human health. The reader is referred to the baseline risk assessment contained in the Final Remedial Investigation Report, dated July, 1990, for a more comprehensive analysis of exposure pathways and receptors.

2.6 POTENTIAL ROADWAY PLACEMENT

The Indiana Department of Transportation (INDOT), in cooperation with the City of Columbus, is currently developing plans for rerouting State Highway 46 into the City of Columbus. The plans developed by INDOT necessitate having a section of rerouted State Highway 46 pass over the northwest section of the OCL. After passing over the OCL the roadway would then connect to a multi-piered bridge which would span the East Fork of the White River. Although the proposed roadway and bridge has complicated the feasibility study process, the potential for incorporating the roadway and bridge into the OCL remediation offers the distinct advantage of providing beneficial land use of the OCL property which otherwise would be left unused for the foreseeable future.

The rerouting of State Highway 46 and the proposed bridge spanning the river would function as the main thoroughfare into the city from Interstate Highway 65. The roadway itself would slope upwards as it crosses the landfill until it would reach its apex just prior to connecting with the southwestern end of the bridge. The apex of the roadway would rise approximately 30 feet above the existing surface of the landfill. The sides of the roadway would be landscaped with newly planted vegetation and the bridge itself would include ornamental features, such as brass trees, along its span. Prior to implementation, any landscaping activities will first be reviewed by USEPA and IDEM.

The method of construction that has been developed by INDOT and their roadway/bridge designer, Butler, Fairman & Seufert, Inc., calls for placing the roadway and its underlying roadway fill material directly on top of the landfill. The actual roadway surface would be placed on compacted roadway fill material which would range in thickness from approximately 8 to 30 feet above the existing landfill surface. The roadway fill material would taper out in a horizontal direction beneath the roadway surface so as to evenly distribute the load on to the landfill. The roadway would be connected to the bridge near the northeastern edge of the landfill with the bridge support at this location being accomplished by a foundation placed within the upper portion of the roadway fill material. More specific information on how the roadway would be constructed, including details on how it would impact the existing landfill cover, are presented in Section 5.5 of this report.

The anticipated construction schedule for the roadway and bridge would provide for placement of the roadway fill material approximately six to nine months in advance of constructing the roadway surface and the bridge. This time frame would allow for the waste material and roadway fill material to approach their full subsidence prior to placing the roadway surface and constructing the bridge connection.

Since the proposed roadway and bridge has generated extensive support on both the state and local level, this feasibility study, under agreement with both the USEPA and IDEM, has incorporated the proposed roadway and bridge into the development and assessment of the remedial alternatives that are applicable to the OCL remediation. To facilitate the potential inclusion of the proposed roadway and bridge into the OCL remediation, each of the remedial alternatives that are presented later in this report have been developed and assessed for implementation in combination with the proposed roadway and bridge. Detailed descriptions of the proposed design and construction of the roadway and bridge, and how they would impact the various remedial alternatives that have been developed, are presented in Section 5.0 of this report.

To establish the compressibility characteristics of the landfill waste material and to verify the technical feasibility of constructing the roadway over the landfill, a preload test has been proposed to the agencies. The geotechnical and environmental aspects of the preload test have been summarized in the proposal report entitled "Environmental Monitoring and Contingency

Plan for Landfill Loading Activities" (G&M 1990b). The results of the preload test will be summarized in a technical supplement to the feasibility study. This technical supplement will summarize the geotechnical and environmental data collected during the preload testing program, present the expected magnitude and rate of settlement and the potential for future releases that would result from placement of the roadway, and discuss how the test results impact the assessment of the developed remedial alternatives.

3.0 DEVELOPMENT OF REMEDIAL RESPONSE OBJECTIVES

3.1 EVALUATION OF ENVIRONMENTAL MEDIA

In order to develop suitable remedial response objectives for the protection of human health and the environment, the various media that may have been impacted by the landfill operation were first analyzed so that appropriate response criteria could be established. These criteria set forth the maximum contaminant concentration limits beyond which response actions must be taken. They also establish the requirements for source control and the elimination or mitigation of potential exposure pathways for the various media of concern at the OCL site. The response criteria that have been established for the media of concern at the OCL site are presented below:

3.1.1 Air

The RI concluded that significant releases of contaminants into the atmosphere have not occurred. ARARs that are pertinent to air releases would apply to any future releases to the atmosphere, including those that may occur during site remediation activities. As a result, response criteria for the air at the OCL site can be limited to the minimization of future air releases so that the pertinent ARARs can be met.

3.1.2 Surficial Soil

Response criteria for the protection of human health and the environment relative to surficial soil are health-based levels, established on a case-by-case basis, based on the potential for ingestion, dermal contact and/or inhalation of airborne releases.

The results of the RI concluded that the concentrations of constituents detected in the surficial soil did not vary significantly from background levels. The RI baseline risk assessment determined that the risk associated with current and hypothetical future exposure to the surficial soil are within acceptable health-based guidelines. As a result, corrective action involving the surficial soil is not necessary for the remediation of the OCL. Preventative action, however, may be required to limit dust generation during the proposed placement of the roadway. Possible preventative action for dust control is discussed in Section 5.5 of this report.

3.1.3 Subsurface Soil

Response criteria for the protection of human health and the environment relative to subsurface soil are also health-based levels, established on a case-by-case basis, based on the potential for ingestion, dermal contact, and/or exposure through releases into the other environmental media. Since the RI concluded that concentrations of constituents detected in the subsurface soil adjacent to the landfill do not vary significantly from background levels, corrective action involving the subsurface soil is not necessary for the remediation of OCL.

3.1.4 Ground Water

The necessity for ground water cleanup actions generally occurs when the constituent concentrations exceed maximum contaminant levels (MCLs) promulgated by the Safe Drinking Water Act (SDWA). Ground-water cleanup actions, however, are not considered necessary for the current OCL situation because the two ground-water sampling rounds conducted as part of the RI did not detect any hazardous constituents at concentrations approaching their respective MCLs.

Based on the results of the RI, the high water table elevation measured from October, 1988 to November, 1989 lies below the lowest detected placement of the landfill material. Due to the lack of historical water table elevation data it is not possible to ascertain what the maximum water table elevation would be and at what frequency it would occur. Since a portion of the landfill waste material lies within the 100 year flood plain it is probable that the water table has risen up into the waste material some time in the past. However, if substantial contaminant releases have occurred in the past as a result of ground water rising up into the landfill waste material, then residuals from any substantial contaminant releases would likely be evident in the ground water.

The determination that ground-water cleanup and/or control actions are not warranted for the current OCL situation is further justified by the existing low levels of ground-water indicator parameters (i.e. sulfate, chloride, specific conductance, etc.). As discussed in Section 2.5.4, the ground-water indicator parameters are extremely low and within the range of background levels. As a result, it can be concluded that the ground water has not been adversely impacted by the landfill even though appreciable amounts of infiltration may pass down through the waste material into the underlying ground water and the water table most likely rises up into the waste material during relatively infrequent flooding events. Thus, ground-water cleanup and/or control actions are not considered necessary for the current OCL situation.

Although the current OCL situation does not justify the necessity for ground-water cleanup and/or control actions, the placement of the proposed roadway and preload test fills on the landfill may adversely affect the underlying ground water. Due to the compaction of the waste material that would result from the roadway placement and preload test fills, there would exist an increased potential for the generation of leachate. This leachate could potentially carry contaminants down into the underlying aquifer, thus, adversely affecting ground-water quality. The expected degree of waste compaction and the potential for ground-water contamination as a result of placing the roadway over the landfill will be thoroughly assessed based on the results of the preload testing program (refer to Section 2.6) and continuous monitoring throughout the project. This assessment will be presented in a technical supplement to the feasibility study, which will be available to the agencies and to the public prior to selection of a remedy. Any changes in the ground-water flow direction and hydraulic gradient found to be resultant of the preload testing will also be discussed in the technical supplement to the feasibility study. With or without placement of the proposed roadway, if it was determined that there was a significant increase of constituents into the ground water such that MCLs were exceeded, then ground-water cleanup and/or control actions would be required. The necessity for implementing ground-water cleanup and/or control actions some time in the future would be determined based on the results of ground-water monitoring.

3.1.5 Surface Water

Surface water response criteria are MCLs for the protection of human health, if ingestion were to occur, and Federal Water Quality Criteria (FWQC) for the protection of the environment. The surface water analysis done as part of the RI concluded that only one hazardous constituent, bis-2-ethylhexyl phthalate, exceeded its MCL or FWQC limit. However, since bis-2-ethylhexyl phthalate was detected at similar concentrations upstream of the OCL site, corrective actions as a result of contaminant release to the East Fork of the White River are not considered necessary for the OCL situation at this time. In the future, should any contaminant releases, directly attributable to the OCL, exceed MCLs, FWQC, and background levels, remediation will be required.

3.1.6 River Sediments

Response criteria for the protection of human health and the environment relative to contaminated river sediments are health-based levels, established on a case by case basis, based on the potential for ingestion and/or dermal contact. Since the RI concluded that concentrations of constituents detected in the river sediments adjacent to the OCL site did not vary significantly from background levels, corrective action involving the river sediments is not considered necessary for the OCL situation.

3.1.7 Landfill Waste Material

Response criteria for the protection of human health and the environment relative to landfill waste material are also health-based levels, established on a case-by-case basis, based on the potential for ingestion and/or dermal contact. For the specific situation at the OCL site, the waste material contained in the landfill constitutes the source of the chemical constituents of concern and, thus, prevention of ingestion and direct contact, as well as the prevention of future releases into the various other media, will be required for the protection of public health and the environment.

3.2 REMEDIAL RESPONSE OBJECTIVES

The previous discussion established which of the environmental media potentially impacted by the presence of the OCL need to be considered in developing the remedial response objectives for the OCL remediation effort. It is apparent from the results of the RI that the environmental media, apart from the waste material contained in the landfill, have not been significantly affected by the presence of the OCL such that protection of human health and the environment has been jeopardized. As a result, the focus of the OCL remedial response objectives will not be on cleanup action but rather the continued assurance that human health and the environment will not be adversely impacted by the existence of the OCL. The specific remedial response objectives that have been developed for remedial response at the OCL are as follows:

- Minimize the direct contact with or ingestion of the landfill waste material.
- Minimize the significant release of constituents from the landfill waste material into the underlying aquifer in order to adequately protect the surface waters of the East Fork of the White River and the gravel quarry pond.
- Minimize the significant release of constituents from the landfill waste material into the air or into the surface waters of the East Fork of the White River or the gravel quarry pond that may result from the surface exposure of the landfill waste material.
- Minimize the possible risk to human health that would exist from the direct consumption of ground water that may become contaminated in the future.
- Minimize the migration of ground water that may become impacted in the future.

For the remedial response objectives, significant release of constituents refers to the level of release that would cause chemical-specific ARARs to be exceeded for either the air, surficial soil, ground water, or surface water surrounding the OCL site. Since the remedial response objectives focus on source control rather than media cleanup, the remedial response objectives do not give reference to target cleanup levels. To identify remedial technologies that could be used to meet the remedial response objectives, a series of general response actions have been developed.

3.3 GENERAL RESPONSE ACTIONS

General response actions are defined as general measures that may be implemented to achieve the remedial response objectives. The general response actions serve to categorize technologies which may be pertinent to the remediation and/or control measures identified in the remedial response objectives. Consistent with the remedial response objectives formulated for the OCL situation, general response actions have been developed to identify technologies which would minimize releases, threats of release, or potential pathways of contaminant exposure. The following general response actions have been developed as the most logical available means that are to be considered for meeting the remedial response objectives.

General Response Actions:

- **No Action** - Provides a baseline for comparison.
- **Institutional Controls** - Provides environmental monitoring as well as institutional restrictions on land use, land access, and well placement.
- **Waste Containment** - Provides measures to prevent the release of contaminants into the various environmental media.
- **Waste Treatment** - Provides for the reduction of toxicity, mobility or volume of the contaminants.
- **Waste Disposal** - Provides for the removal and disposal of the contaminants.
- **Provisional Ground-Water Collection and Treatment** - Provides for the recovery and treatment of any ground water that may become adversely impacted in the future.

Figure 3-1 presents the relationship between the environmental media of concern at the OCL site, the remedial response objectives associated with these media, and the general response actions developed to reach the remedial response objectives. The following sections evaluate the remedial technologies that are applicable to the general response actions.

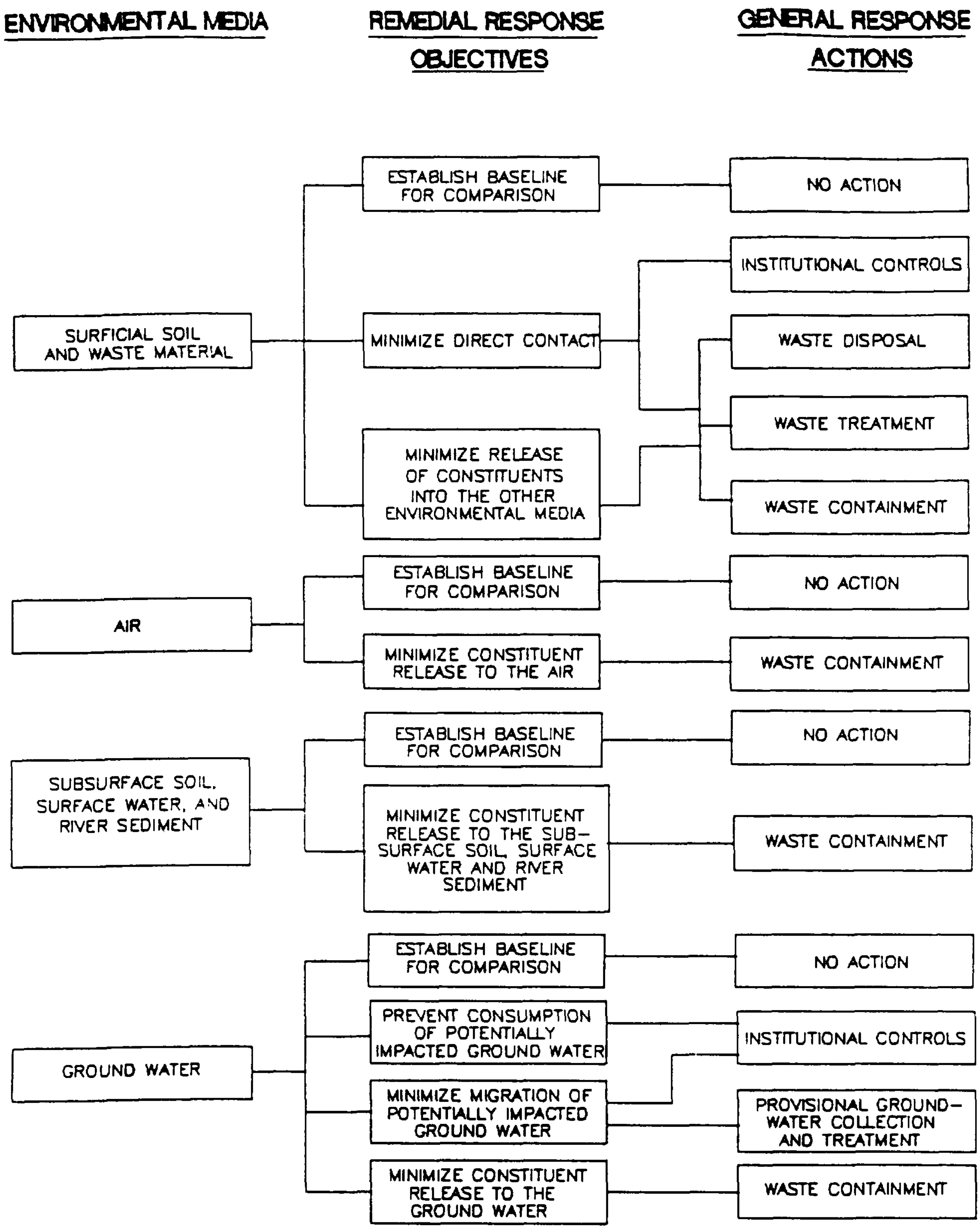

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FIGURE 3-1
GENERAL RESPONSE ACTIONS FOR THE ENVIRONMENTAL MEDIA OF CONCERN
FEASIBILITY STUDY
THE OLD CITY LANDFILL COLUMBUS, INDIANA

4.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

This section presents the identification and screening of remedial technologies for potential applicability to the OCL situation. Based on their applicability to the general response actions presented in Section 3.3, a number of potential remedial technologies have been identified. The following sections describe and evaluate the remedial technologies that have been identified as potentially applicable to the OCL situation.

4.1 SCREENING OF REMEDIAL TECHNOLOGIES

The identified remedial technologies are those technologies that could potentially meet the function of the general response actions and, thus, serve to attain the remedial response objectives. Figures 4-1 through 4-4 present the remedial technologies that have been identified for the general response actions associated with the environmental media of concern at the OCL site. The identified remedial technologies are further categorized into their process option components. Process options refer to the specific processes available within a generally technology.

In accordance with the recommendations presented in the USEPA RI/FS Guidance Document (USEPA 1988a) the potentially applicable remedial technologies are first evaluated on the basis of their technical implementability relative to the OCL site conditions. If considered technically feasible, the remedial technologies are further evaluated on the basis of their effectiveness, implementability, and cost. If possible, one process option is chosen for each technology type in order to simplify the subsequent development and evaluation of remedial alternatives.

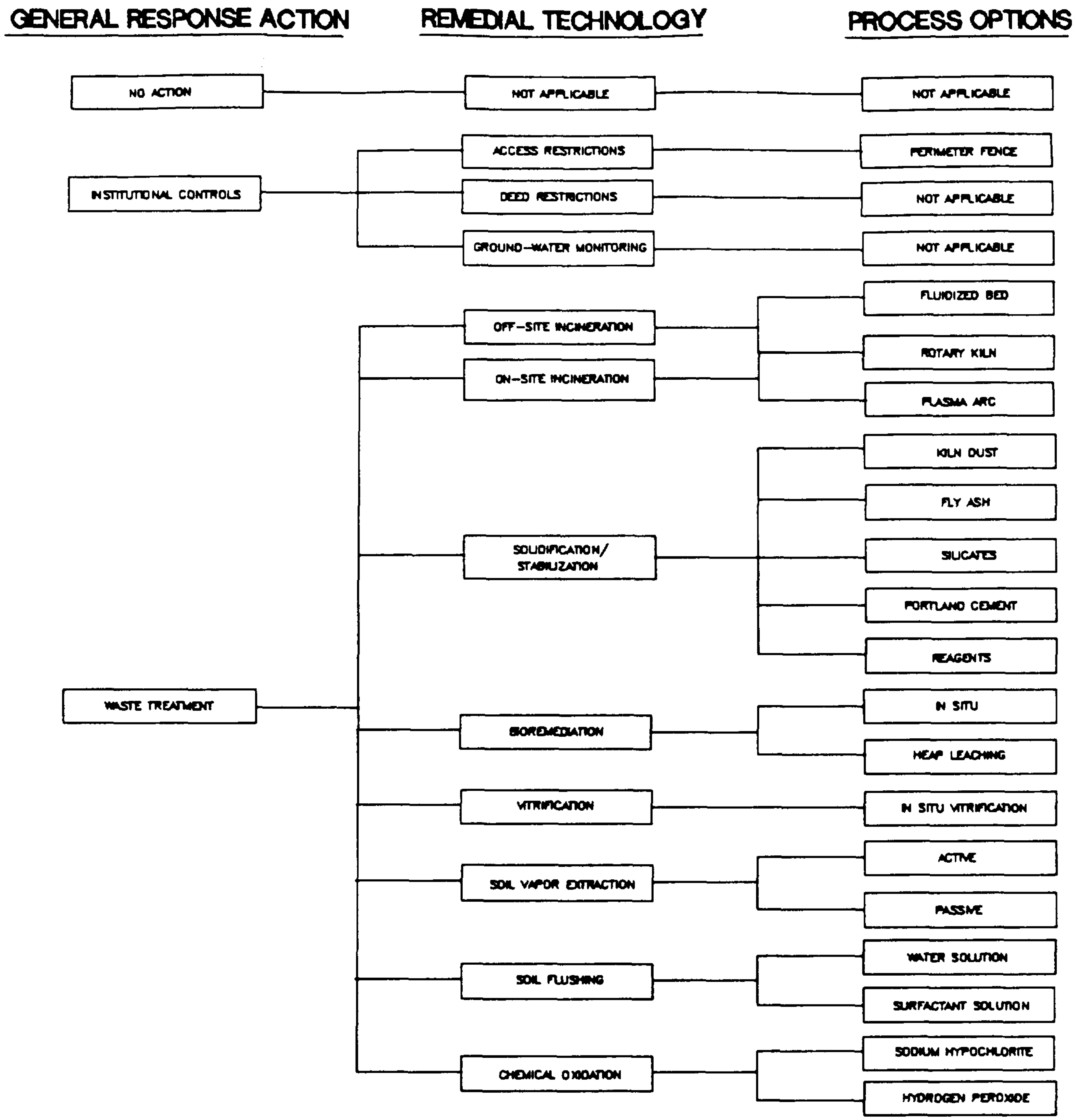

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FIGURE 4-1
POTENTIAL REMEDIAL TECHNOLOGIES FOR THE WASTE MATERIAL AND SURFICIAL SOIL (PAGE 1 OF 2)
FEASIBILITY STUDY
OLD CITY LANDFILL COLUMBUS, INDIANA

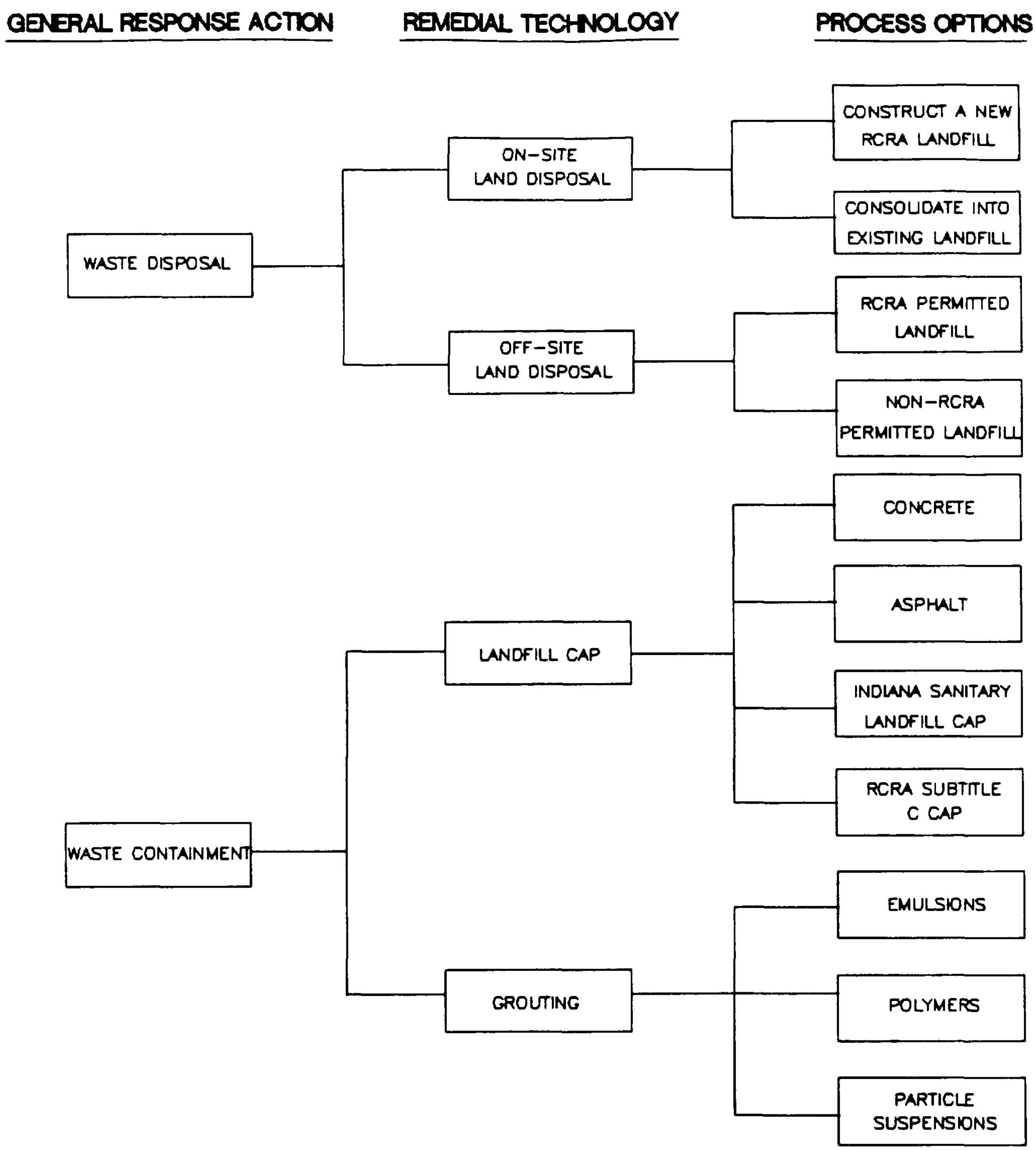

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FIGURE 4-1
POTENTIAL REMEDIAL TECHNOLOGIES FOR THE WASTE MATERIAL AND SURFICIAL SOIL (PAGE 2 OF 2)
FEASIBILITY STUDY
OLD CITY LANDFILL COLUMBUS, INDIANA

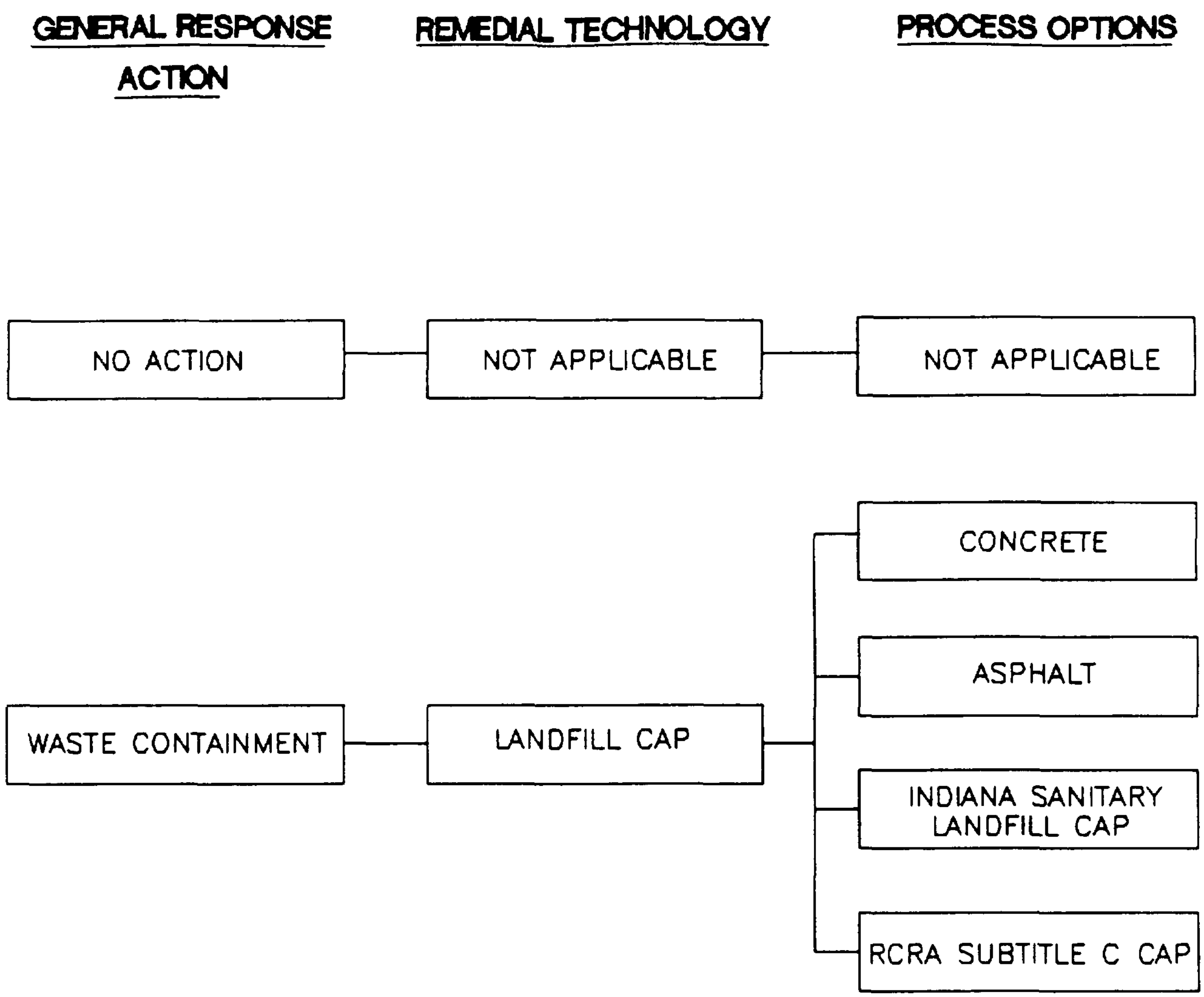

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FIGURE 4-2
POTENTIAL REMEDIAL TECHNOLOGIES FOR AIR EMISSIONS CONTROL
FEASIBILITY STUDY
OLD CITY LANDFILL COLUMBUS, INDIANA

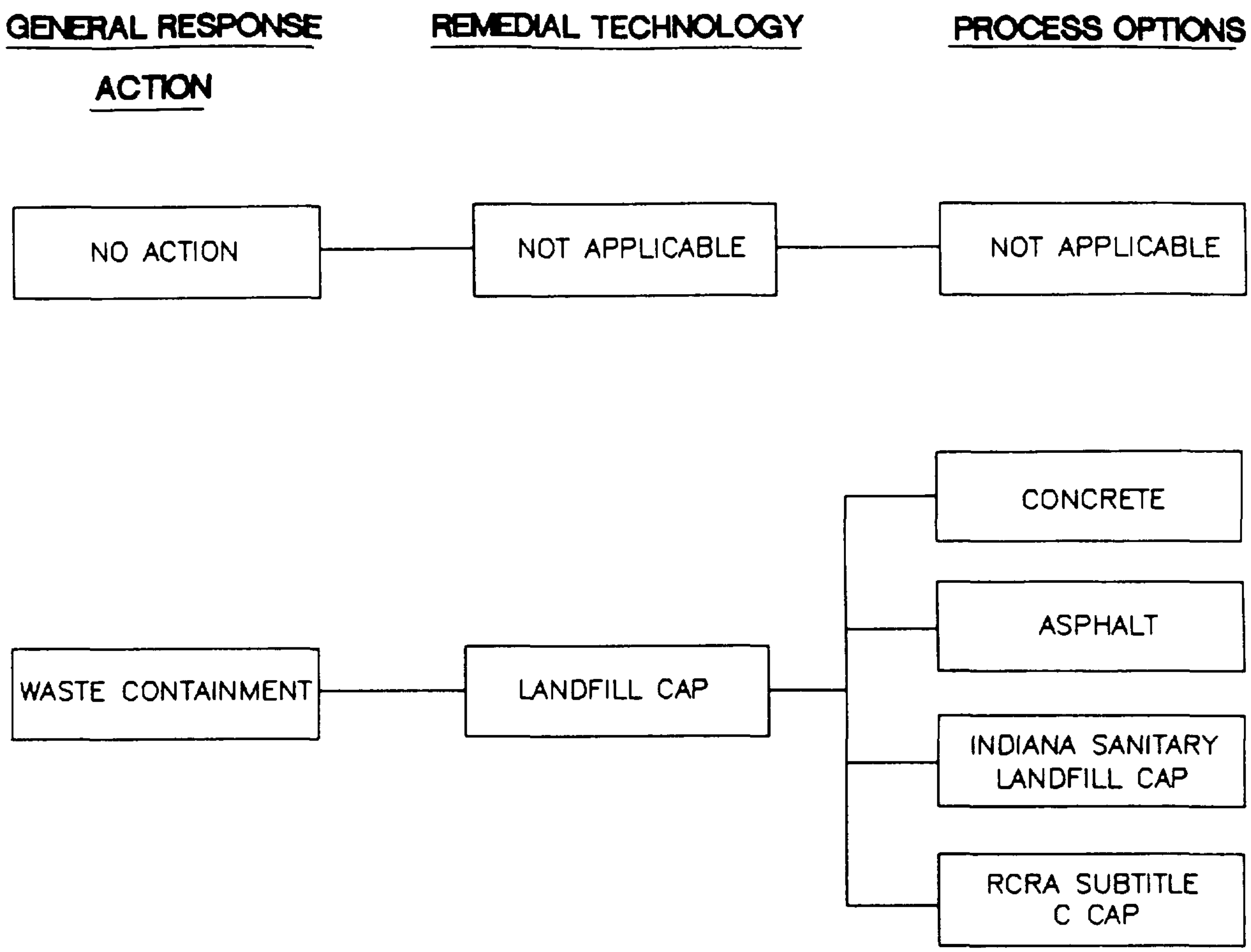

FIGURE 4-3

POTENTIAL REMEDIAL TECHNOLOGIES FOR THE SUBSURFACE SOIL, SURFACE WATER, AND RIVER SEDIMENT

FEASIBILITY STUDY

OLD CITY LANDFILL COLUMBUS, INDIANA

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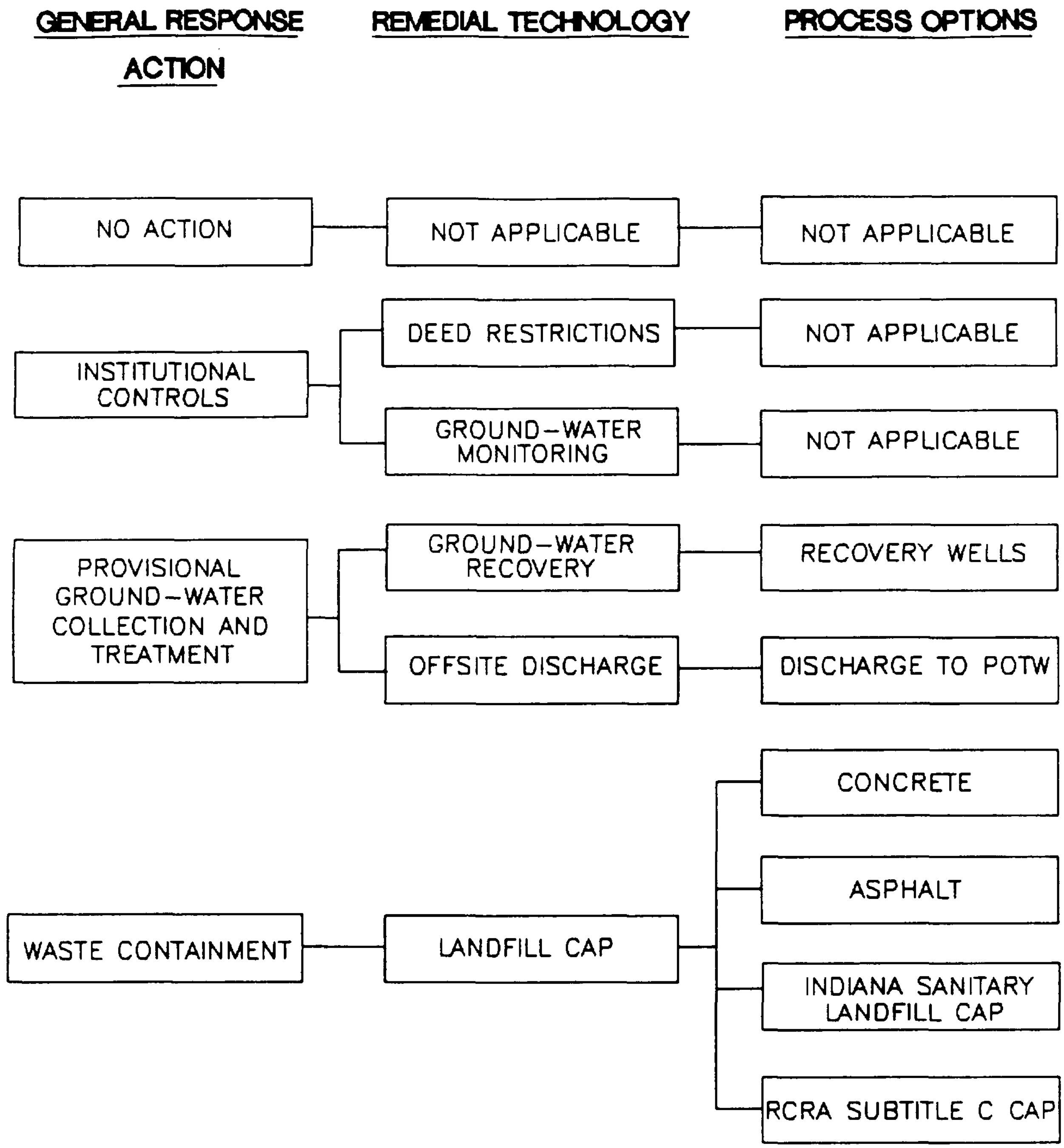

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FIGURE 4-4
POTENTIAL REMEDIAL TECHNOLOGIES FOR GROUND WATER
FEASIBILITY STUDY
OLD CITY LANDFILL COLUMBUS, INDIANA

Effectiveness, which is given the most importance in this technology evaluation process, is defined as the degree to which a technology can attain the remedial response objectives, ensure the protection of human health and the environment during its implementation, and be considered reliable and proven with respect to the contaminants and conditions at the site. However, innovative technologies which provide permanent remedies are also given equal consideration in accordance with the intent of CERCLA, Section 121.

Implementability, which considers both technical and institutional implementability, is defined as the ability of a given technology to be compatible with the constituents and conditions at the site, the ability to obtain any necessary permits, the availability of treatment, storage or disposal capacity, and the availability of required equipment and trained personnel.

The cost evaluation criteria plays a limited role in the technology screening process. The relative capital, operation and maintenance costs associated with each given technology are the basis for comparison. Relative costs presented in this section are estimated on the basis of engineering judgement, and each process is evaluated relative to the process options in the same technology type. These relative costs are presented as low, medium or high.

The identified remedial technologies and their respective process options, grouped under the general response action categories, are screened for effectiveness, implementability, and cost in Table 4-1. The remedial technology process options which would be ineffective in meeting the remedial response objectives, difficult to implement at the OCL site, or prohibitively expensive relative to the other process options for a remedial technology have been eliminated from further consideration. Sections 4.2 and 4.3 discuss the remedial technologies and their respective process options that have been identified and screened for applicability to the remediation of the OCL.

Table 4-1. Screening of Remedial Technologies and Process Options - Old City Landfill, Columbus, Indiana

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
Institutional Controls					
Access Restrictions	Perimeter Fence	a. Prohibits unauthorized entry. b. Minimizes potential for direct contact with or incidental ingestion of the landfill waste.	a. Equipment, materials and contractors available.	Low	Yes
Deed Restrictions	None	a. Effective for protecting human health by controlling land use and preventing unauthorized ground water extraction. b. Depends on continued future implementation.	a. Could be easily implemented on the local level.	Low	Yes
Ground-Water Monitoring	None	a. Very effective in assessing whether constituent releases have occurred into the ground water. b. Can be used as the basis for determining if further remedial action is warranted. c. Requires a long-term commitment.	a. Could be easily implemented using a number of the existing monitoring wells.	Low	Yes
Waste Containment					
Landfill Cap	Concrete Cap	a. Potentially effective option, although susceptible to weathering and cracking. b. Aesthetically unpleasant over 19 acre site.	a. Materials and equipment available. b. Future land use restrictions apply. c. Heavy vehicle traffic required to the site during its construction.	Medium	No
	Asphalt Cap	a. Potentially effective option, although susceptible to weathering and cracking. b. Aesthetically unpleasant over 19 acre site.	a. Materials and equipment available. b. Heavy vehicle traffic required to the site during its construction.	Medium	No

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
	Indiana Sanitary Landfill Cap	a. Effective waste containment option b. High degree of long-term effectiveness since clay layer has self-healing properties.	a. Materials and equipment available. b. Future land use restrictions apply. c. Heavy vehicle traffic required to the site during its construction. d. Large volumes of clay maybe difficult to obtain.	Medium	Yes
	RCRA Subtitle C Cap	a. Effective waste containment option b. High degree of long-term effectiveness since clay layer has self-healing properties.	a. Materials and equipment available. b. Future land use restrictions apply. c. Heavy vehicle traffic required to the site during its construction. d. Large volumes of clay may be difficult to obtain.	High	Yes
Grouting	Emulsions	a. Potentially effective method for consolidating and sealing subsurface areas.	a. Controlling diffusion of grout through waste and below would be very difficult. b. Grout may flow beyond waste area and contaminate ground water.	High	No
	Polymers	a. Potentially effective method for consolidating and sealing subsurface areas.	a. Controlling diffusion of grout through waste and below would be very difficult. b. Grout may flow beyond waste area and contaminate ground water.	High	No
	Particle Suspensions	a. Potentially effective method for consolidating and sealing subsurface areas.	a. Controlling diffusion of grout through waste and below would be very difficult. b. Grout may flow beyond waste area and contaminate ground water.	High	No
Waste Treatment					
On-Site Incineration	Fluidized Bed	a. Not effective in treating inorganics. b. Requires complete excavation of the landfill material creating the potential for endangerment to human health and the environment.	a. Limited availability. b. Regulatory requirements for air emissions and ash disposal. c. Extremely expensive due to large volume of waste material.	Very High	No

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
	Rotary Kiln	a. Not effective in treating inorganics. b. Requires complete excavation of the landfill material creating the potential for endangerment to human health and the environment.	a. Available. b. Regulatory requirements for air emissions and ash disposal. c. Extremely expensive due to large volume of waste material.	Very High	No
	Plasma Arc	a. Not effective in treating inorganics. b. Requires complete excavation of the landfill material creating the potential for endangerment to human health and the environment. c. Not a proven incineration technology.	a. Limited availability. b. Regulatory requirements for air emissions and ash disposal. c. Extremely expensive due to large volume of waste material.	Very High	No
Off-Site Incineration	Fluidized Bed	a. Not effective in treating inorganics. b. Requires complete excavation of the landfill material creating the potential for endangerment to human health and the environment.	a. Available. b. Potential for waste exposure to humans and/or environment during transportation to off-site facility. c. Extremely expensive due to large volume of waste material.	Very High	No
	Rotary Kiln	a. Not effective in treating inorganics. b. Requires complete excavation of the landfill material creating the potential for endangerment to human health and the environment.	a. Available. b. Potential for waste exposure to humans and/or environment during transportation to off-site facility. c. Extremely expensive due to large volume of waste material.	Very High	No
	Plasma Arc	a. Not effective in treating inorganics. b. Requires complete excavation of the landfill material creating the potential for endangerment to human health and the environment. c. Not a proven incineration technology	a. Limited availability. b. Potential for waste exposure to humans and/or environment during transportation to off-site facility. c. Extremely expensive due to large volume of waste material.	Very High	No

Table 4-1. Screening of Remedial Technologies and Process Options - Old City Landfill, Columbus, Indiana

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
In-Situ Solidification/ Stabilization	Kiln Dust Reagent	a. Potentially effective in reducing the mobility and toxicity of the contaminants. b. Effectiveness reduced due to extreme heterogeneous nature of landfill material and inability to test treated waste. c. Not nearly as effective as on-site solidification/stabilization.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Injection of reagents into the subsurface may migrate down into the underlying aquifer potentially impacting ground-water quality.	Very High	No
	Fly Ash Reagent	a. Potentially effective in reducing the mobility and toxicity of the contaminants. b. Effectiveness reduced due to extreme heterogeneous nature of landfill material and inability to test treated waste. c. Not nearly as effective as on-site solidification/stabilization.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Injection of reagents into the subsurface may migrate down into the underlying aquifer potentially impacting ground-water quality.	Very High	No
	Silicate Reagent	a. Potentially effective in reducing the mobility and toxicity of the contaminants. b. Effectiveness reduced due to extreme heterogeneous nature of landfill material and inability to test treated waste. c. Not nearly as effective as on-site solidification/stabilization.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Injection of reagents into the subsurface may migrate down into the underlying aquifer potentially impacting ground-water quality.	Very High	No
	Portland Cement Reagent	a. Potentially effective in reducing the mobility and toxicity of the contaminants. b. Effectiveness reduced due to extreme heterogeneous nature of landfill material and inability to test treated waste. c. Not nearly as effective as on-site solidification/stabilization.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Injection of reagents into the subsurface may migrate down into the underlying aquifer potentially impacting ground-water quality.	Very High	No

Table 4-1. Screening of Remedial Technologies and Process Options - Old City Landfill, Columbus, Indiana

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
	Synthetic Reagents	a. Potentially effective in reducing the mobility and toxicity of the contaminants. b. Effectiveness reduced due to extreme heterogeneous nature of landfill material and inability to test treated waste. c. Not nearly as effective as on-site solidification/stabilization.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Injection of reagents into the subsurface may migrate down into the underlying aquifer potentially impacting ground-water quality.	Very High	No
On-Site Solidification/ Stabilization	Kiln Dust Reagent	a. Proven and reliable treatment method. b. Effective since the landfill material could be segregated, thus, reducing the heterogeneity of the landfill material. c. Potentially effective in rendering the waste material non-hazardous as determined by its characteristics. d. Treatability studies required to determine optimal reagent or mix of reagents.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated.	Very High	No
	Fly Ash Reagent	a. Proven and reliable treatment method. b. Effective since the landfill material could be segregated, thus, reducing the heterogeneity of the landfill material. c. Potentially effective in rendering the waste material non-hazardous as determined by its characteristics. d. Treatability studies required to determine optimal reagent or mix of reagents.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated. d. Fly ash reagent is readily available.	Very High	Yes

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Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
	Silicate Reagent	a. Proven and reliable treatment method. b. Effective since the landfill material could be segregated, thus, reducing the heterogeneity of the landfill material. c. Potentially effective in rendering the waste material non-hazardous as determined by its characteristics. d. Treatability studies required to determine optimal reagent or mix of reagents.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated.	Very High	No
	Portland Cement Reagent	a. Proven and reliable treatment method. b. Effective since the landfill material could be segregated, thus, reducing the heterogeneity of the landfill material. c. Potentially effective in rendering the waste material non-hazardous as determined by its characteristics. d. Treatability studies required to determine optimal reagent or mix of reagents.	a. Relatively difficult to implement. b. Extremely expensive due to high volume of waste material. c. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated.	Very High	No
	Synthetic Reagent	a. Proven and reliable treatment method. b. Effective since the landfill material could be segregated, thus, reducing the heterogeneity of the landfill material. c. Potentially effective in rendering the waste material non-hazardous as determined by its characteristics. d. Treatability studies required to determine optimal reagent or mix of reagents.	a. Potentially limited quantity of additives available b. Extremely expensive due to high volume of waste material. c. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated.	Very High	No

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
Bioremediation	In-Situ	a. Ineffective for inorganics. b. Difficulty expected in evenly distributing nutrients, and possibly inoculating micro-organisms, throughout the waste material.	a. Difficult to control in-situ biological processes. b. Nutrient additives may migrate down to the underlying aquifer potentially impacting ground-water quality.	Medium	No
	Heap Leaching	a. Ineffective for inorganics b. May cause the development of unpleasant odors.	a. Available technology. b. Requires construction of heap-leaching facility. c. Increased potential for con-taminant releases to other environmental media since the waste material would have to be excavated.	High	No
Vitrification	In-Situ Vitrification	a. Potentially effective method for the immobilization of metals. b. Unproven for large-scale applications. c. Heterogeneous nature of waste material may cause some areas not to become fully vitrified.	a. Very Limited availability. b. Extremely expensive due to the large volume of waste material that would need to be vitrified.	Very High	No
Soil Vapor Extraction	Active	a. Ineffective for the removal of of inorganics and non-volatile organics.	a. Available technology. b. Would most likely require drilling through the waste material to install extraction wells.	Medium	No
	Passive	a. Ineffective for the removal of of inorganics and non-volatile organics.	a. Available technology. b. Would most likely require drilling through the waste material to install extraction wells.	Medium	No
Soil Flushing	Water Solution	a. Limited effectiveness on the removal of low solubility organics and inorganics. b. The waste material has not proven to be amenable to soil flushing.	a. Available technology. b. A leachate or ground water recovery and treatment system would be required.	High	No

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Table 4-1. Screening of Remedial Technologies and Process Options - Old City Landfill, Columbus, Indiana

Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
	Surfactant Solution	a. Limited effectiveness on the removal of low solubility organics and inorganics. b. The waste material has not proven to be amenable to soil flushing.	a. Available technology. b. A leachate or ground water recovery and treatment system would be required.	High	No
Chemical Oxidation	Sodium Hypochlorite	a. Limited effectiveness for the treatment of inorganics. b. Unproven technology for the treatment of solid waste.	a. Solid waste may have to be excavated and slurried in order for the treatment process to be effective.	Very High	No
	Hydrogen Peroxide	a. Limited effectiveness for the treatment of inorganics. b. Unproven technology for the treatment of solid waste	a. Solid waste may have to be excavated and slurried in order for the treatment process to be effective.	Very High	No
<u>Waste Disposal</u>					
Onsite Land Disposal	Construct a New RCRA Landfill	a. Effective for the long-term protection of human health and the environment.	a. Prohibitively expensive due to the large volume of waste material. b. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated. c. Would require compliance with very stringent siting, construction, and operating requirements for RCRA landfill.	Very High	No
	Consolidate Into Existing Landfill	a. Effective for protecting human health and the environment. b. Would be applicable if the waste material was excavated, treated, and then disposed of back in the landfill. c. Degree of treatment and disposal requirements would be dictated by analytical results and ARARs.	a. Future land use restrictions would be required. b. Covering the landfill would be required. c. Would require treatment of the waste material.	High	Yes

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Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Retain
Offsite Land Disposal	RCRA Permitted Landfill	a. Transportation of the waste material required. b. Effective for the long-term protection of human health and the environment. c. Only viable for small volumes of waste material (i.e. drill cuttings and other small volumes of waste generated during site investigations and/or site remediation.	a. Treatment of landfill waste required prior to disposal at a RCRA facility, if deemed necessary. b. Prohibitively expensive due to the large volume of waste material. c. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated and transported.	Very High	No
	Non-RCRA Permitted	a. Transportation of the waste material required.	a. Treatment of landfill waste required prior to disposal. b. Increased potential for contaminant releases to other environmental media since the waste material would have to be excavated and transported.	Very High	No
<u>Provisional Ground-Water Collection and Treatment</u>					
Ground-Water Recovery	Recovery Wells	a. Very effective in containing and collecting ground water. b. Requires periodic inspection and maintenance.	a. Installation of recovery wells could be readily accomplished. b. Requires pump test and analytical modelling to properly design recovery well system.	Medium	Yes
Off-Site Discharge	Discharge to POTW	a. Very effective means for treating recovered ground water. b. Requires inspection and maintenance of the transmission system.	a. Requires connection to the City's sewer system or installation of a new transmission line to the POTW. b. Recovered ground water would have to meet the pretreatment limits established as part of the agency approved POTW pretreatment program for the City of Columbus.	Medium	Yes

Legend: (shaded) Remedial technology and process option retained for further consideration.

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4.2 DISCUSSION OF APPLICABLE REMEDIAL TECHNOLOGIES

This section presents a brief discussion of the remedial technologies and their respective process options that are applicable for inclusion into the remedial alternatives for the remediation of the OCL. The remedial technologies are grouped in accordance with the general response action categories.

4.2.1 Institutional Controls

4.2.1.1 Access Restrictions

Access to the OCL site could be effectively restricted by placing a chain link fence around the periphery of the landfill. This peripheral fence would also enclose any highway, ramp, or bridge approachway that may be constructed. A peripheral fence, which would be inexpensive and easy to construct, would be effective in minimizing the potential for direct contact with the landfill waste material. The peripheral fence would satisfy the security requirements of both 329 IAC 3-16-5 and 329 IAC 3-21-8(b) by restricting public access to the site.

4.2.1.2 Deed Restrictions

Institutional restrictions placed on future land use for the OCL property as well as institutional restrictions placed on ground-water wells within a prescribed radius of the OCL site would be an effective means for minimizing the potential for direct contact with or ingestion of the landfill waste or any ground water that may potentially become contaminated as a result of contaminant leaching. The deed restrictions would comply with the applicable land use and post-closure requirements set forth in IAC 3-16-5, IAC 3-21-7, and IAC 3-21-8(c). Deed restrictions are readily implemented and offer long-term effectiveness.

4.2.1.3 Ground-Water Monitoring

Periodic monitoring of the ground water at the OCL site would be an effective means for verifying that the protection of human health and the environment is being accomplished and for assessing the effectiveness of the overall remediation effort. Although ground-water monitoring would require a long-term commitment it would be relatively inexpensive and easy to implement. The ground-water monitoring program would utilize the existing monitoring well network, including those wells (Monitoring Wells MW-14 through MW-23) recently installed for the landfill loading monitoring program, for periodically assessing the ground-water quality at the OCL site.

4.2.2 Waste Containment

The following applicable waste containment technologies fall under the general remedial technology of landfill capping. Even though they can be considered process options for landfill capping they are listed as separate technologies since they offer varying degrees of effectiveness, implementability, and cost.

4.2.2.1 Sanitary Landfill Cap

Placing a landfill cap over the extent of the waste material would be an effective means for minimizing water infiltration through the waste material that may cause the leaching of contaminants into the underlying ground water. Capping the landfill would also minimize the potential for direct contact with the waste material as well as limiting the potential for surface exposure of the waste material. A sanitary landfill cap, designed and constructed in accordance with Indiana's Solid Waste Management Regulations 329 IAC 2-14-19 would be a viable means for capping the landfill. The sanitary landfill cap, which would consist primarily of a 2 foot compacted clay layer under a 6 inch layer of vegetated topsoil, would be moderately expensive but effective and relatively easy to implement.

4.2.2.2 RCRA Subtitle C Cap

An alternative means of waste containment by application of a final cover is that of a RCRA Subtitle C Cap which would be designed and constructed in accordance with the requirements specified under 40 CFR 264. The technical requirements for RCRA Subtitle C Caps, which were developed for the closure of RCRA permitted disposal facilities, include a 2 foot minimum upper vegetative layer, a 12 inch minimum drainage layer, and a low permeability layer of compacted clay in combination with a synthetic liner. A RCRA Subtitle C cap would have a high degree of long-term effectiveness; however, it would be relatively expensive and more difficult to implement than the sanitary landfill cap.

4.2.3 Waste Treatment

4.2.3.1 On-Site Solidification/Stabilization

Solidification/stabilization is a waste treatment process that utilizes the addition of one or more chemical reagents in order to reduce the mobility and toxicity of the contaminants contained in the waste material. Solidification is the process by which an additive is mixed into the waste to produce a monolithic block that has no free liquids, improved structural integrity, and limited surface area across which leaching could occur. Stabilization is the process by which the additive mixed into the waste causes chemical reactions to occur such that the contaminants become more chemically stable, thus, rendering them less soluble, less mobile, and/or less toxic. The solidification/stabilization process can be conducted either in-situ or above ground (i.e., on-site) which, for the purpose of this FS, are considered as two separate waste treatment technologies. Process options available for solidification/stabilization involve the type of reagent(s) added. Reagents that could potentially be effective in solidifying/stabilizing the OCL waste material include kiln dust, fly ash, silicates, portland cement, as well as various synthetic reagents. A treatability study would have to be conducted to establish which reagent or combination of reagents would be the most effective in solidifying/stabilizing the OCL waste material. Because fly ash is readily available and is used frequently as a solidifying/stabilizing reagent, it has been selected as the preferred process option for this assessment of the on-site solidification/stabilization technology. In order for the solidification/stabilization treatment process to be effective, the waste to be treated must be homogeneous in nature. Since the landfill waste at the OCL is extremely heterogeneous in nature the waste material would first have to be excavated and segregated prior to undergoing solidification/stabilization treatment in mixing vessels located on-site. The excavated wastes would be stored in either roll-off boxes, meeting the requirements of 329 IAC 3-48, or waste piles, managed per the requirements of 329 IAC 3-51, prior to undergoing treatment. In addition, the treatment vessels would comply with the tank requirements set forth in 329 IAC 3-49. Following treatment, the solidified/stabilized waste material would be disposed of back in the landfill. A potential drawback to this treatment technology is that excavating the waste would increase the potential for contaminant releases to the other environmental media. Although it would be effective in reducing the mobility, and possibly the toxicity, of the contaminants contained in the landfill waste material, on-site solidification/stabilization would be extremely expensive and relatively difficult to implement.

4.2.4 Waste Disposal

4.2.4.1 On-Site Disposal

On-site disposal would be used if the landfill material would be excavated, treated on-site, and then buried back in the existing landfill. A constraining aspect of this disposal option is that

RCRA Land Disposal Restrictions (LDRs) are an identified ARAR for the disposal of any excavated landfill waste material. RCRA LDRs would be triggered if the excavated material was found to be a hazardous waste in accordance with the RCRA hazardous waste characteristic testing procedures listed under 40 CFR 261 (Subpart C). If the waste material was found to be a RCRA hazardous waste, then the applicable RCRA LDR would require that the waste material be subjected to stringent treatment and disposal requirements. The disposal requirements would necessitate that the existing landfill would have to be modified to comply with the minimum technology requirements for a RCRA Subtitle C landfill in accordance with 40 CFR 264. The RCRA Subtitle C disposal requirements would not apply if the waste material was treated to a point where it would be rendered non-hazardous. In addition, RCRA LDR treatment and disposal requirements would not apply if the excavated waste material was tested and found not to be a hazardous waste, as determined by its characteristics. Provided that the waste material does not display hazardous characteristics or could be treated to a level where it would be rendered non-hazardous, then on-site disposal would be an effective and easily implemented disposal option for any excavated waste material.

4.2.5 Provisional Ground-Water Collection and Treatment

The following ground-water collection and treatment technologies are presented to address what actions could be taken if the ground water at the OCL site would become adversely impacted by the landfill some time in the future. The potential for the groundwater to become adversely impacted by the existence of the landfill may increase if the proposed roadway and bridge were to be placed on the landfill. The resultant compaction of the waste material might cause a release of leachate into the underlying ground water. Ground-water collection and treatment actions would only be implemented if significant releases of constituents were occurring into the ground water. In this context, significant releases generally refers to any constituent that is detected in two or more ground-water samples, taken from the same monitoring well, at concentrations exceeding its respective MCL. If an MCL has not been established for a particular constituent, then a health-based criterion based on USEPA human health evaluation guidance manuals will be calculated. A detailed description of the intended procedure for determining if ground-water collection and treatment actions are warranted is presented in the proposed "Environmental Monitoring and Contingency Plan for Landfill Loading Activities" (G&M 1990b), which will become part of the administrative record following agency approval. The methodology for determining the necessity of ground-water response actions would apply regardless of whether the roadway is placed over the landfill.

Since ground-water collection and treatment would only be implemented on a provisional basis (i.e. if the ground water were to become adversely affected) the wide array of available ground-water collection and treatment technologies are not identified and evaluated in this FS report. To simplify the inclusion of this provisional action only the most viable ground-water collection and treatment technologies are identified and evaluated.

4.2.5.1 Ground-Water Recovery

Ground-water recovery, utilizing recovery wells or subsurface drains, is a commonly employed means for the containment and/or collection of contaminated ground water. Due to the favorable hydrogeologic conditions at the OCL site, a series of recovery wells or subsurface drains would be very effective in containing and collecting any adversely impacted ground water. Since recovery wells are easier to install and maintain than are subsurface drains, and could be more easily coordinated with the placement of the proposed roadway, recovery wells would be the recommended means of ground-water recovery should that action be necessary sometime in the future. Implementation of a ground-water recovery well system, although moderately expensive, could be readily accomplished.

4.2.5.2 Off-Site Discharge

Any adversely impacted ground water that is collected would have to be treated to meet all applicable Clean Water Act requirements as well as all applicable state and local requirements. The most viable means for accomplishing this at the OCL site would be to discharge the collected ground water to the City of Columbus sewer system where it would then be transmitted to the POTW for treatment. This would be a very effective and reliable method of treating the recovered ground water and would preclude the necessity for having on-site treatment. However, compliance with the pretreatment limits for the City of Columbus, established as part of its agency approved POTW pretreatment program would be required in order to discharge into the sewer system. Off-site discharge to the POTW would be relatively inexpensive compared to other treatment options and would also be relatively easy to implement. The implementation of this treatment option would necessitate the design and installation of a transmission system to an appropriate sewer manhole or lift station.

4.3 DISCUSSION OF INAPPLICABLE REMEDIAL TECHNOLOGIES

This section presents a brief discussion of the remedial technologies and their respective process options that are inapplicable for inclusion into the alternatives that will be evaluated for the remediation of the OCL. The remedial technologies are grouped in accordance with the general response actions.

4.3.1 Waste Containment

4.3.1.1 Grouting

Grouting is a commonly employed technique for consolidating and sealing subsurface areas. The grouts used for subsoil consolidation and ground-water control include emulsions, polymers, and particle suspensions injected under pressure into the subsurface formation. These materials are generally water-based solutions of sufficiently low viscosity to penetrate soil voids. After a period of time, the grout solidifies thus decreasing the permeability of the soil and waste material and the rate at which water would move through the formation. In the case of the OCL subsurface materials, the adjustment in the grout consistency needed to remediate the relatively impervious waste materials would render the control of its diffusion through the waste and below very difficult. Since the layers underneath the waste are characterized by a much higher permeability than that of the waste material, the grout may uncontrollably flow beyond the waste area and leach into the ground water. Grouting technology is therefore not considered an appropriate technology for waste containment at the OCL.

4.3.1.2 Asphalt Cap

Placement of an asphalt surface over the extent of the waste material could be used as a means for capping the landfill. An asphalt cap would be reasonably effective in protecting human health and the environment by reducing water infiltration through, and preventing direct contact with, the waste material. However, since an asphalt cap would be highly susceptible to weathering and cracking, its long-term effectiveness may be limited. Although an asphalt cap could be readily implemented from a technical standpoint, there may be community resistance in placing an asphalt surface over a highly visible 19 acre site. Since other landfill cap options (i.e., Indiana Sanitary Landfill Cap and RCRA Subtitle C Cap) would offer a similar degree of implementability but a higher degree of effectiveness, an asphalt cap is not considered an appropriate technology for waste containment at the OCL.

4.3.1.3 Concrete Cap

Placement of a concrete surface over the extent of the waste material could also be used as a means for capping the landfill. However, since the evaluation of a concrete cap is identical to the evaluation of an asphalt cap presented above, a concrete cap is not considered an appropriate technology for waste containment at the OCL.

4.3.2 Waste Treatment

4.3.2.1 Bioremediation

Bioremediation involves the use of indigenous and/or supplanted microorganisms for the biological degradation of various organic compounds. Through enzyme catalyzed reactions, microorganisms are able to degrade various organic contaminants into nontoxic byproducts. The bioremediation process options include in-situ bioremediation and heap leaching (i.e., compositing). In-situ would consist of "seeding" the landfill with microorganisms. Heap leaching would consist of removing the contaminated soil and debris from the landfill, piling the material on prefabricated mats, and then "seeding" the waste piles with microorganisms. Both process options would require the periodic addition of nutrients in order to ensure suitable microorganism growth. Because the waste material at OCL contains heavy metals, which can be toxic to microorganisms, and only trace amounts of organic contaminants, the effectiveness of bioremediation using either method would be very limited. Thus, bioremediation is determined to be an inapplicable technology for waste treatment at the OCL.

4.3.2.2 Soil Vapor Extraction

Soil vapor extraction involves the capture and removal of VOCs from the vadose zone (i.e., subsurface zone above the water table) utilizing either an active or passive extraction system. Either system would require the installation of extraction wells screened in the vadose zone within the confines of the landfill. A passive system would rely on natural soil venting to remove any volatilized organics. An active system would induce a negative vacuum through the extraction wells in order to strip off the VOCs from the waste material. The effectiveness of this treatment technology, however, would be extremely marginal since only small amounts of VOC's were detected in the waste material. The inorganic contaminants in the waste material would not be removed by the soil vapor extraction process. Since only trace amounts of volatile organic contaminants would be removed by its application, soil vapor extraction is not considered an applicable technology for waste treatment at the OCL.

4.3.2.3 In-Situ Solidification/Stabilization

By the in-situ injection and mixing of additives into the landfill waste material the mobility, and possibly the toxicity, of the waste contaminants may be reduced due to the solidification and/or stabilization of the material. However, as stated in Section 4.2.3.1, for the solidification/ stabilization treatment process to be effective, the waste material must be homogeneous in nature. Since the buried landfill waste is extremely heterogenous in nature it is unlikely that in-situ solidification/stabilization would be effective in adequately reducing the mobility and/or toxicity of the constituents contained in the landfill waste. In addition, there would be no representative means for inspecting and testing the waste after it has been treated and the in-situ injection of reagents may actually migrate down into the underlying aquifer thus potentially impacting the ground-water quality. For these reasons, in-situ solidification/stabilization is not considered an appropriate technology for waste treatment at the OCL.

4.3.2.4 Soil Flushing

Soil flushing is used to promote the leaching of contaminants by allowing a liquid solution to percolate through the waste material. The resultant leachate would then be collected via a leachate and/or ground-water collection system and passed through a treatment system so that contaminants could be removed. The degree to which contaminants are leached out during soil flushing depends primarily on their respective water solubility limits and adsorption characteristics. Organic compounds are more amenable to soil flushing removal than are inorganic compounds, especially when surfactants are added to the flushing solution (USEPA 1986a). If the OCL waste material were amenable to soil flushing treatment then more contaminants would have been found in the ground water as a result of the many years of water infiltration that has percolated through the existing landfill cover and the waste material. Soil flushing is therefore not considered an appropriate technology for waste treatment at the OCL.

4.3.2.5 Chemical Oxidation

Chemical oxidation is a well established means for treating both hazardous and non-hazardous waste by using oxidation reactions to change the oxidation state of a substance, thus, altering its toxicological properties. Although its use is widespread, chemical oxidation has traditionally only been used in treating liquids; however, more recently it has been effectively applied to the treatment of slurries and sludges. Chemical oxidation can break down organic compounds into nontoxic byproducts but does not, in general, significantly alter the toxic properties of most inorganics, such as heavy metals. Since the vast majority of contaminants in the landfill waste are inorganics and since chemical oxidation has not been proven effective in the treatment of solid wastes, chemical oxidation is not considered an appropriate technology for waste treatment at the OCL.

4.3.2.6 Vitrification

In-situ vitrification would be accomplished by inserting electrodes in and around the landfill. A voltage would be applied between the electrodes to raise the temperature of the soil and waste material above its melting point causing the volatilization and/or destruction of the VOCs. Nonvolatile organic and inorganic elements would be enveloped by the resultant molten soil mass which, upon cooling, would form a geologically stable crystalline, solid glass. The destruction of VOCs and the immobilization of the other primary constituents of concern, especially the metals, makes this treatment very effective. However, this is a developing technology that has undergone only limited full-scale testing. There is currently only one unit commercially available thus significantly limiting the implementability of this treatment option. In addition, vitrification is a prohibitively expense treatment option which, for the 19 acre OCL site, could easily exceed $100,000,000. Since vitrification is a relatively untested new technology that would be prohibitively expensive and difficult to implement, it is not considered an applicable technology for waste treatment at the OCL.

4.3.2.7 On-Site Incineration

Incineration is a common means for the destruction of hazardous materials. In the incineration process extremely high temperatures are created such that all organic material, in either gas, liquid, or solid form, will undergo combustion. The combustion of hazardous organic compounds will lead to the breakage of chemical bonds such that the hazardous organic compounds will be broken down into nonhazardous byproducts. Inorganic substances, including heavy metals, do not undergo combustion during the incineration process and, thus, their toxicological properties are not significantly altered.

As stated above, incineration is only effective in the thermal breakdown of organic substances. Since inorganics are not subjected to thermal destruction, the ash that results from the incineration process contain all the nonvolatilized inorganics, including heavy metals (Freeman 1989). The presence of significant concentrations of heavy metals in the material to be incinerated is also a concern since it can result in elevated emissions of heavy metals which are difficult to collect with air pollution control equipment (USEPA 1986b). For incineration to be an effective treatment process, it is apparent that the waste material must have an adequate concentration of organic substances, in order to provide fuel for the combustion process and to limit the volume of ash generated, and a minimal concentration of heavy metals.

As discussed in Section 2.4.7, the waste material observed during the RI landfill sampling consisted primarily of general refuse (paper and plastic), black ash and cinders, demolition debris (bricks, concrete, and wood), ceramic material,and metal shavings. With respect to USEPA Target Compounds List (TCL) constituents, the landfill sample analyses confirmed that the vast majority of the constituents in the waste material are heavy metals. Table 2-6, which presents the occurrence of constituents in the landfills samples collected during the RI, illustrates that there are moderate concentrations of heavy metal constituents but only minor concentrations of organic constituents in the waste material. A summation of the average detected concentrations shown in Table 2-6 for the detected volatile organics, base/neutral and acid compounds, and pesticides/PCBs yields the total percentage of organic constituents of potential concern in the OCL waste material to be less than 0.0029%, by weight (28.87 mg/kg). This is a very conservative estimate since the average detected concentration values were utilized in this summation estimate even though the majority of the organic constituents were only detected in two or less of the eight samples analyzed. In comparison, the heavy metal constituents (not including aluminum, calcium, iron, magnesium, manganese, potassium, and sodium) account for approximately 0.303%, by weight (3031 mg/kg), of the OCL waste material. The predominance of heavy metal constituents versus organic constituents of potential concern, which exceeds over two orders of magnitude, in the OCL waste material is also evidenced by the extremely low concentrations of organic constituents, if detected at all, measured in the environmental media surrounding the OCL.

The presence of heavy metals in the OCL waste material may actually preclude compliance with the substantive requirements of an operating permit for an on-site incinerator or create a violation of the operating permit for an off-site incinerator. Current USEPA guidelines on the substantive requirements of hazardous waste incinerator operating permits require that limits be placed on the concentrations of toxic metals contained in the waste material to be incinerated (USEPA 1988). The metals that are regulated under USEPA permitting guidelines include arsenic, barium, chromium, beryllium, cadmium, antimony, lead, mercury, and silver, all of which were detected in the OCL waste material. The exact limits established for the toxic metal feed rate limits are site specific based on effective stack height, terrain characteristics, and local land use (USEPA 1988). At the present time, it is uncertain whether or not an on-site or off-site incinerator would meet the substantive requirements of an operating permit to incinerate the OCL waste material.

Based on the above discussion, it is apparent that incineration would have a very low degree of implementability since the technology may not be compatible with the constituents at the site and it may be difficult to obtain an operating permit. The overall effectiveness of incineration is also considered low because the waste material would have to be excavated prior to treatment and the treatment process residual would still contain hazardous constituents (i.e, heavy metals). Excavating the waste material may jeopardize the protection of human health and the environment, since there would be an increased potential for contaminant releases to other environmental media. As stated previously, the ash residual from the incineration process, although reduced in size from the original waste material volume, would still contain heavy metals that could be subjected to leaching. In order to comply with RCRA LDRs the incinerator ash may have to undergo additional treatment prior its ultimate land disposal.

Although the cost evaluation criteria only plays a limited role in the technology screening process it is beneficial in assessing the relative cost-effectiveness of the various technologies and process options considered. Recent cost estimates for on-site incineration of contaminated soils range from $150 to $500 per ton (USEPA 1986a, Bowers 1988). Conservatively assuming one cubic yard of OCL waste material weighs approximately 1,000 pounds (NCRR 1974) the estimated cost for on-site incineration of the 500,000 cubic yards of waste material at the OCL ranges from $37,500,000 to $125,000,000. Note that these cost estimates do not include the cost to treat and dispose of the incinerator ash. Even at the low end of the estimate range it is apparent that on-site incineration would be prohibitively expensive when measured against other treatment technologies, such as on-site solidification/stabilization, which would be more effective and suitable for the waste constituents found at the OCL.

From the above discussion it can be concluded that on-site incineration is not an applicable technology for waste treatment at the OCL.

4.3.2.8 Off-Site Incineration

Off-site incineration would occur at a commercially owned RCRA permitted facility. However, for the reasons presented above for on-site incineration, in addition to the potential risks to public health and the environment associated with transporting approximately 500,000 cubic yards of waste material to an off-site incinerator, off-site incineration is not considered an applicable technology for waste treatment at the OCL.

4.3.3 Waste Disposal

4.3.3.1 On-Site RCRA Landfill Disposal

This disposal option would require construction of a RCRA Subtitle C compliant landfill on-site so that the waste material could be excavated and then placed within the RCRA landfill. Due to the difficulty in meeting the stringent technical requirements for the installation and operation of a RCRA compliant landfill, in addition to its prohibitively expensive cost, an on-site RCRA compliant landfill is not considered an applicable disposal option for the waste material within the OCL.

4.3.3.2 Off-Site RCRA Landfill Disposal

Off-site disposal in a RCRA permitted landfill could be applied if the waste material was excavated and hauled off-site. Due to the large volume of waste material present in the OCL, off-site RCRA landfill disposal is not considered a viable disposal option. With the volume of waste material estimated to be 500,000 cubic yards it is anticipated that over 10,000 truck loads would be required to transport the waste to the nearest RCRA permitted landfill (a commercially owned RCRA permitted landfill facility near Fort Wayne, Indiana). This transport effort, in addition to taking years to complete, may be objectionable to the general public and would potentially endanger human health and the environment due to the accidental release of contaminants during excavation and transport. In addition, the waste material may need to be treated in order to comply with RCRA LDRs. The cost for off-site RCRA landfill disposal could easily exceed $50,000,000. Due to the major logistical difficulties associated with its implementation, the increased risks to human health and the environment that may occur during excavation and transport, and its prohibitively expensive costs, off-site RCRA landfill disposal is not considered an applicable disposal option for the full volume of waste material within the OCL.

Off-site RCRA landfill disposal would, however, be applicable if a small portion of the waste material required disposal during remedial activities or during the construction of the proposed roadway and bridge. This would only apply for small volumes of waste material such as soil boring cuttings or isolated areas of waste material excavation.

4.3.3.3 Off-Site Non-RCRA Landfill Disposal

This disposal option would apply if the landfill waste was to be excavated and treated to a level were the waste would be rendered nonhazardous, assuming the waste displayed RCRA hazardous characteristics to begin with. With the landfill waste being rendered nonhazardous it could be disposed of in a non-RCRA permitted landfill. However, if the landfill waste was rendered nonhazardous the justification for disposing of the waste off-site as opposed to on-site disposal could not be made. As a result, off-site non-RCRA landfill disposal is not considered an applicable disposal option for the waste within the OCL.

4.4 SUMMARY OF APPLICABLE REMEDIAL TECHNOLOGIES

The preceding sections along with Table 4-1 presented the evaluation that was done to determine the applicability of the identified remedial technologies to the remediation of the OCL. From this evaluation a limited number of remedial technologies were determined to be applicable to the general response actions required for meeting the remedial response objectives. For each applicable remedial technology the most effective process option was selected unless two or more process options would offer similar levels of effectiveness, but would vary in their costs and degree of compliance with the potentially relevant regulations. Figure 4-5 presents the remedial technologies, along with their representative process option(s), that have been determined to be applicable for meeting the OCL remedial response objectives. By combining the applicable remedial technologies within the framework of the general response actions a limited number of remedial alternatives have been developed. These remedial alternatives are presented in the following section.

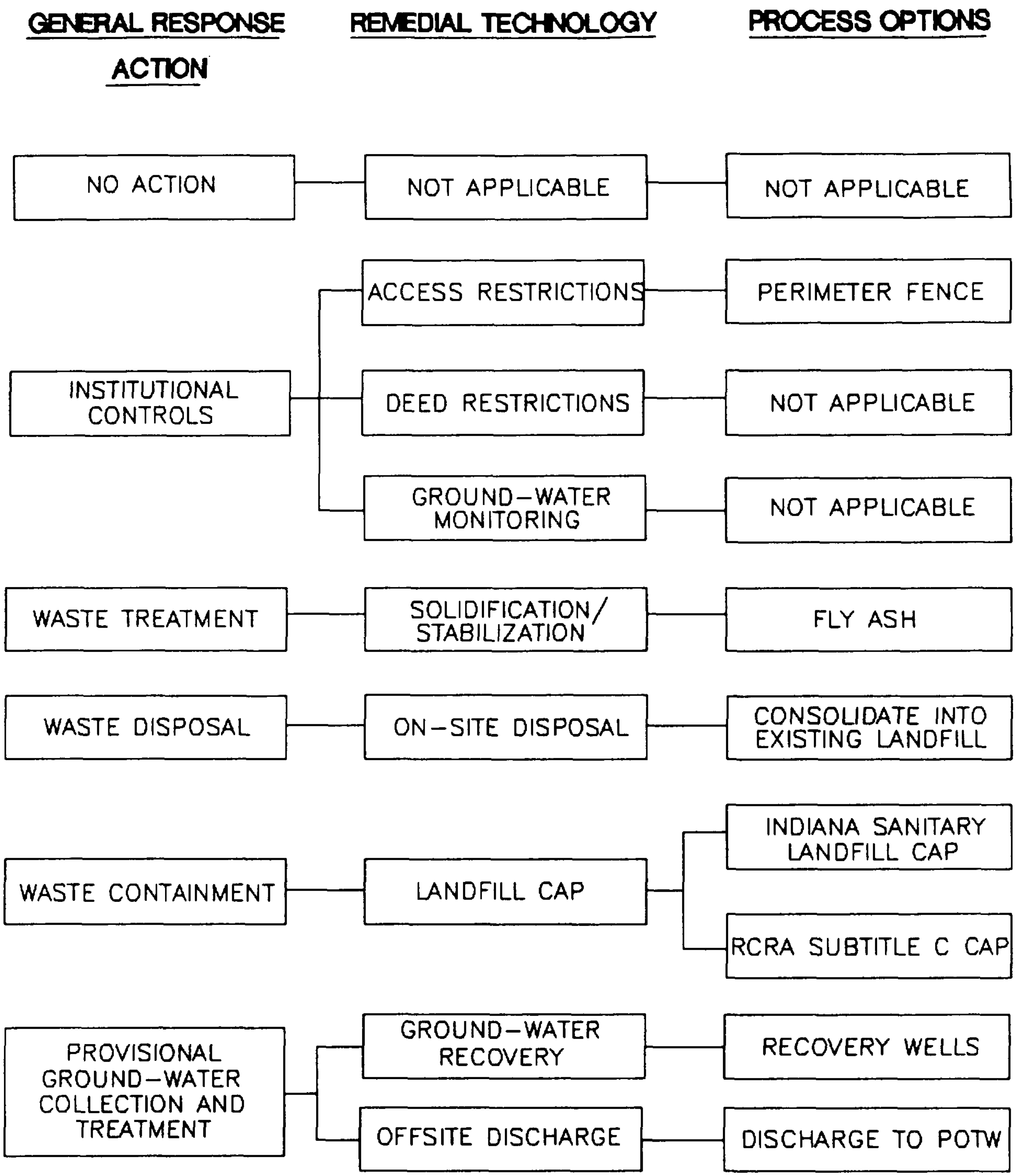

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FIGURE 4-6
SUMMARY OF RETAINED REMEDIAL TECHNOLOGIES
FEASIBILITY STUDY
OLD CITY LANDFILL COLUMBUS, INDIANA

5.0 DEVELOPMENT AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

The preceding section identified the remedial technologies applicable to the general response actions that would be required to meet the OCL remedial response objectives. By combining the applicable remedial technologies within the framework of the general response actions, several remedial alternatives have been developed. The developed alternatives are presented in the following section.

5.1 ASSEMBLY OF REMEDIAL ALTERNATIVES

In order to identify an appropriate range of waste management options that focus on source control measures, in accordance with the remedial response objectives, several potentially viable remedial alternatives have been developed. Consistent with Task 9(a) of the Statement of Work and the recommendations presented in the USEPA RI/FS Guidance Document (USEPA 1988), the developed alternatives include alternatives that would provide, collectively or independently, no-action, waste containment and/or waste treatment. Since the evaluation of the environmental media concluded that corrective action is not recommended, at this time, for the environmental media in the vicinity of the OCL, only source control measures pertaining to the landfill waste material were considered in devising the remedial alternatives. To account for the desired placement of the proposed roadway and bridge over the OCL, each of the developed remedial alternatives has been modified, where appropriate, and assessed for compatibility with the proposed roadway and bridge. The five remedial alternatives that have been developed are described and assessed separately for implementation without the proposed roadway and bridge and for implementation with the proposed roadway and bridge. The remedial alternatives that have been developed are listed as follows:

Alternative 1:	No Action
Alternative 1A:	Roadway Placement with No Action
Alternative 2:	Institutional Controls
Alternative 2A:	Roadway Placement with Institutional Controls
Alternative 3:	Sanitary Landfill Cap
Alternative 3A:	Roadway Placement with Sanitary Landfill Cap
Alternative 4:	RCRA Subtitle C Cap
Alternative 4A:	Roadway Placement with RCRA Subtitle C Cap
Alternative 5:	On-Site Solidification/Stabilization
Alternative 5A:	Roadway Placement with On-Site Solidification/Stabilization

Although not indicated above, Alternatives 3, 3A, 4, 4A, 5 and 5A would also include the institutional controls provided under Alternative 2.

5.2 SCREENING OF REMEDIAL ALTERNATIVES

The USEPA RI/FS Guidance Document (USEPA 1988) recommends that the developed remedial alternatives be screened against the general criteria of effectiveness, implementability and cost prior to conducting a detailed analysis of the alternatives. Through this initial screening, the number of remedial alternatives that are to be taken through detailed analysis can be reduced by screening out all except the most promising remedial alternatives. A potentially constraining aspect of this alternative screening process is that the full range of remedies (i.e. no action, waste containment, and waste treatment) should be carried through into the detailed analysis of alternatives.

Due to the lack of suitable treatment technologies for the landfill waste material and the fact that the landfill waste material is the only environmental medium that warrants remedial action, only a limited number of potentially viable remedial alternatives could be developed. Since only a limited number of potentially viable remedial alternatives could be developed, the remedial alternative screening process was not necessary and therefore not conducted. By omitting the optional remedial alternative screening process the developed remedial alternatives have all been carried through into the detailed analysis step. A description of the detailed analysis procedure along with a description and analysis of the individual remedial alternatives are presented in the following sections.

5.3 DESCRIPTION OF DETAILED ANALYSIS CRITERIA

In order to conduct a comprehensive, comparative analysis of the remedial alternatives, each of the remedial alternatives are first assessed against the evaluation criteria that have been developed to address the statutory considerations listed under CERCLA, Section 121. The nine evaluation criteria utilized in assessing the OCL remedial alternatives are in accordance with the detailed analysis criteria specified within the latest version of the NCP (40 CFR 300, Subpart E, Section 300.430, effective April 9, 1990). The nine evaluation criteria are listed as follows:

1. Overall protection of human health and the environment.
2. Compliance with applicable or relevant and appropriate requirements (ARARs)
3. Long-term effectiveness and permanence.
4. Reduction of toxicity, mobility, or volume through treatment.
5. Short-term effectiveness.
6. Implementability.
7. Cost.
8. State acceptance.
9. Community acceptance.

During the detailed analysis, each alternative is objectively assessed against each of the nine criteria. Since the alternatives are analyzed individually, each of the evaluation criteria is given equal weight. After analyzing the individual alternatives, a comparative analysis is then performed to assess the relative performance of each alternative with respect to the evaluation criteria. It is during the comparative analysis, which is presented in Section 5.14, that the relative advantages and disadvantages of an alternative are identified.

The evaluation criteria to be used in analyzing the remedial alternatives are defined in the following sections.

5.3.1 Overall Protection of Human Health and the Environment

This criterion assesses whether alternatives adequately protect human health and the environment. This criterion assesses to what degree an alternative would eliminate, reduce or control the risks to human health and the environment, associated with the site, through treatment, engineering, or institutional controls. It is an overall assessment of protection that evaluates the assessment of other criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

5.3.2 Compliance with ARARs

This criterion determines whether a remedial alternative meets all of its federal and state ARARs that have been identified by the regulatory agencies. If a particular ARAR can not be met by an alternative, then a determination should be made on whether a waiver on the ARAR, as allowed under Section 121 of CERCLA, would be appropriate. All identified chemical-specific ARARs, location-specific ARARs, and action-specific ARARs are considered in making this assessment. Table 5-1 lists the ARARs that have been identified by USEPA and IDEM for the OCL. Based on the identified ARARs, a determination was made as to which ARARs apply to the individual remedial alternatives that have been developed. The applicability of a particular ARAR to each of the remedial alternatives is also shown on Table 5-1.

5.3.3 Long-Term Effectiveness and Permanence

This criterion assesses whether a remedial alternative would carry a potential, continual risk to human health and the environment after the remedial action would be completed. An evaluation is made as to the magnitude of the residual risk present after the completion of the remedial actions as well as the adequacy and reliability of controls that could be implemented to monitor and manage the residual risk that may be present.

5.3.4 Reduction of Toxicity, Mobility or Volume through Treatment

This criterion assesses to what degree a remedial alternative, by utilizing treatment technologies, would permanently and significantly reduce the toxicity, mobility or volume of the hazardous substances at the site. The assessment focuses on the magnitude, significance and irreversibility of the reductions.

5.3.5 Short-Term Effectiveness

This criterion assesses the degree to which human health and the environment would be impacted during the construction and implementation of the remedial alternative. The protection of workers, the community, and the surrounding environment as well as the time to achieve the remedial response objectives are considered in making this assessment.

Table 5-1. Listing of Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Alternatives at the Old City Landfill, Columbus, Indiana

Applicable or Relevant and Appropriate Requirements (ARARs)	Application	Remedial Alternatives 1	1A	2	2A	3	3A	4	4A	5	5A
Action-Specific ARARs											
Federal											
40 CFR 264 .310a .310b .117c	Standards for treatment and disposal of hazardous waste; Capping/closure with waste in-place					x	x	x	x		
40 CFR 264 .258b .310	Standards for treatment and disposal of hazardous waste; Closure with waste in-place					x	x	x	x		
40 CFR 268	Land disposal restrictions; Excavation		x		x		x		x	x	x
40 CFR 230.10	Restrictions on discharge of dredged or fill materials on aquatic ecosystems		x	x	x	x	x	x	x	x	x
CAA 109 111 112	National ambient air quality standards Implementation of ambient air standards; National emission standards for hazardous air pollutants; Air quality control regions; Soil handling		x		x	x	x	x	x	x	x
40 CFR 51.160-164 60.50 52 51.166	Review of new sources and modifications; Approval and promulgation of implementation plans; Soil handling		x		x	x	x	x	x	x	x
40 CFR 264.310	Landfill closure and post-closure care; Operation and maintenance					x	x	x	x	x	x
40 CFR 264.228	Surface impoundment closure and post-closure care		x		x		x		x	x	x
40 CFR 268.41 268	Land disposal restrictions		x		x		x		x	x	x
51 FR 40641 52 FR 25760	Treatment standards for waste which will be land disposed		x		x		x		x	x	x

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Table 5-1. Listing of Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Alternatives at the Old City Landfill, Columbus, Indiana

Applicable or Relevant and Appropriate Requirements (ARARs)	Application	Remedial Alternatives 1	1A	2	2A	3	3A	4	4A	5	5A
40 CFR 403 [see note 1]	General pretreatment regulations for existing and new sources of pollution; Ground water Collection and Discharge			x	x	x	x	x	x	x	x
State											
329 IAC 3-53-2	Design and operating requirements for permitted hazardous waste landfills							x	x		
329 IAC 3-50-5 3-51-6 3-46-1 through 3-46-8 3-46-11 3-51-3	Closure and post-closure care of surface impoundments, waste piles, and landfills; Final (state) permitted facility standards; Closure and post-closure; Capping/Closure with waste in-place					x	x	x	x		
326 IAC 6-4 6-5	Fugitive dust emissions; Fugitive particulate matter emission limitations; Soil handling		x		x	x	x	x	x	x	x
326 IAC 2-1 8-1 et al	Construction and operating permit requirements; Volatile organic compound rules; Soil handling		x		x	x	x	x	x	x	x
329 IAC 3-53-5 329 IAC 2-12-2 329 IAC 2-15-7	Closure and post-closure care of sanitary landfills			x	x	x	x	x	x	x	x
329 IAC 3-21-8	Post-closure care and use of property			x	x	x	x	x	x	x	x
329 IAC 3-21-10	Post-closure notices regarding hazardous waste landfill closure			x	x	x	x	x	x	x	x
329 IAC 2-14-19	Final cover requirements for sanitary landfills					x	x	x	x		
329 IAC 2-4-4b(2)	Cover requirements and nuisance control for open dumps		x		x	x	x	x	x	x	x

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Table 5-1. Listing of Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Alternatives at the Old City Landfill, Columbus, Indiana

Applicable or Relevant and Appropriate Requirements (ARARs)	Application	Remedial Alternatives 1	1A	2	2A	3	3A	4	4A	5	5A
327 IAC Article 5	General pretreatment and NPDES discharge requirements; Provisional ground water collection and discharge			x	x	x	x	x	x	x	x
329 IAC 2-16 329 IAC 3-20	Ground Water Monitoring			x	x	x	x	x	x	x	x
329 IAC 3-48	Use and management of containers for storing hazardous waste		x		x		x		x	x	x
329 IAC 3-16-5	Minimize unauthorized or unwanted site entry by persons or animals to hazardous waste facility		x	x	x	x	x	x	x	x	
329 IAC 3-51	Final permitted facility standards for waste piles including design, operation, monitoring, and inspection requirements along with closure and post-closure care		x		x	x	x	x	x	x	x
327 IAC 2-1	State water quality standards			x	x	x	x	x	x	x	x
<u>Chemical-Specific ARARs</u>											
<u>Federal</u>											
40 CFR 264.94	Ground water concentration limits for hazardous substances;	x	x	x	x	x	x	x	x	x	x
SDWA	Primary drinking water standards, MCLs and non-zero MCLGs	x	x	x	x	x	x	x	x	x	x
CAA 109 40 CFR 50	National ambient air quality standards	x	x	x	x	x	x	x	x	x	x
CAA 112 40 CFR 61	National emission standards for hazardous air pollutants	x	x	x	x	x	x	x	x	x	x

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Table 5-1. Listing of Applicable or Relevant and Appropriate Requirements (ARARs) for Remedial Alternatives at the Old City Landfill, Columbus, Indiana

Applicable or Relevant and Appropriate Requirements (ARARs)	Application	Remedial Alternatives 1	1A	2	2A	3	3A	4	4A	5	5A
CWA 402 40 CFR 122 123 125	USEPA requirements for NPDES; state NPDES programs; and criteria and standards for NPDES					x	x	x	x		
CWA 307(b)	General pretreatment requirements; Provisional ground water collection and discharge			x	x	x	x	x	x	x	x
State											
329 IAC 3-45-5	Ground water concentration limits for hazardous constituents; MCLs	x	x	x	x	x	x	x	x	x	x
326 IAC 2-1	Construction and operating permit requirements; National ambient air quality standards	x	x	x	x	x	x	x	x	x	x
326 IAC 1-3	Ambient Air Quality Standards	x	x	x	x	x	x	x	x	x	x
326 IAC 14-1 through 14-8	National emissions standards for hazardous air pollutants	x	x	x	x	x	x	x	x	x	x
Location-Specific ARARs											
Federal											
40 CFR 264.18b 40 CFR Pt. 6 APP A	Location standards; Within 100 year floodplain		x	x	x	x	x	x	x	x	x
State											
329 IAC 3-41-9(b)	Floodplain location standards; Within 100-year floodplain		x	x	x	x	x	x	x	x	x

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5.3.6 Implementability

This criterion assesses the technical and administrative feasibility of implementing a remedial alternative and the availability of services and materials required during implementation. The ability to construct and operate the technologies included as part of an alternative, the reliability of these technologies, the ease of obtaining any necessary permits, the ease of undertaking additional remedial action if required, and monitoring requirements are considered in assessing the technical and administrative feasibility of implementing an alternative. The availability of treatment, storage capacity, disposal services, necessary equipment, and personnel are considered in assessing the availability of services and materials required for implementing a remedial alternative.

5.3.7 Costs

This criterion assesses the capital costs, operation and maintenance costs, and total present worth analysis associated with implementing a remedial alternative. The capital costs are divided into direct costs and indirect costs. Direct capital costs include construction costs, equipment costs, site development costs, and disposal costs. Indirect capital costs include engineering expenses, legal fees and license or permit costs, start-up costs and contingency allowances.

Operation and maintenance (O&M) costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. These costs include operating labor costs, maintenance materials and labor costs, auxiliary materials and energy. These costs also include disposal of residues, administrative costs, insurance and licensing costs, maintenance contingency funds, rehabilitation costs and costs of periodic site reviews if required.

The cost estimates presented in this FS report were developed utilizing the Remedial Action Costing Procedures Manual (USEPA 1985); Means Building Construction Cost Data (Means, 1990); Means Site Work Cost Data (Means 1990) and quotations from various vendors and material supplies. In accordance with EPA guidance, the costs estimates are expected to provide an accuracy of +50 to -30 percent (USEPA 1988).

After development of the capital and operation and maintenance costs, a present worth analysis of remedial action costs is conducted. A present worth analysis relates costs that occur over different time periods to present costs by discounting all future costs to the present value. This allows the cost of remedial alternatives to be compared on the basis of a single figure that represents the money required in today's dollars to construct, operate and maintain the remedial alternatives throughout their planned life. For the purposes of this detailed analysis, a period of 30 years is chosen for the performance period of the remedial alternatives (USEPA 1988).

5.3.8 State Acceptance

This criterion assesses the technical and administrative issues and concerns the state may have regarding each of the remedial alternatives. This assessment can not be made until after the state provides its input to the USEPA's Proposed Plan. Since state acceptance of the remedial alternatives is unknown at this time it is not addressed in the detailed analysis of alternatives.

5.3.9 Community Acceptance

This criterion assesses the issues and concerns the public may have regarding each of the remedial alternatives. This assessment can not be fully made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan.

Utilizing the aforementioned nine evaluation criteria each of the remedial alternatives has been taken through a detailed analysis. The results of these analyzes are presented in the following sections.

5.4 ALTERNATIVE 1 : NO ACTION

Alternative 1 is the "no action" alternative.

5.4.1 Detailed Description

Alternative 1 represents the "no action" alternative. As its name implies, actions would not be implemented to provide for source control or monitoring of the environmental media to determine if contaminant releases were occurring. This alternative would simply be a continuation of the no action practiced at the OCL site, apart from the RI investigative work, since it ceased operating in the mid to late 1960s.

5.4.2 Assessment

The results of assessing Alternative 1 against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The results of the RI (G&M 1990) concluded that the risks to human health and the environment associated with the existence of the OCL, in its present condition, are within acceptable health-based and environmental quality-based guidelines. Even though water infiltration passes downward through the overlying surficial soil into the landfill waste material, creating a favorable pathway for contaminant release, significant releases of contaminants have not been observed during investigations completed in recent years. The apparent physically inert nature of the contaminants within the landfill waste material indicates that future releases of contaminants into the environmental media underlying the OCL are unlikely. As a result, the "no action" alternative is expected to provide, at a minimum, a marginally adequate degree of protection to human health and the environment. However, since ground-water monitoring would not be provided to verify that contaminant releases were not occurring, inspections would not be made of the existing landfill cover to ensure the waste material does not become exposed, and provisions would not be implemented to prevent direct contact with or ingestion of the waste material, the "no action" alternative would not limit any future increased risks to human health and the environment.

Compliance with ARARs

At the present time, all chemical-specific ARARs are being met for the environmental media at the OCL. Unless significant releases of contaminants were to occur some time in the future, all chemical-specific ARARs would continue to be met. Since remedial actions would not be undertaken at the site, the identified action-specific and location-specific ARARs would not apply to the "no-action" alternative. This is consistent with USEPA policy which has established that "no-action" alternatives, if selected as a remedy by the USEPA, do not need to comply with ARARs (USEPA 1989a). Thus, the "no-action" alternative does not need to comply with such items as the Indiana Sanitary Landfill Closure Requirements, which are relevant and may be appropriate for the OCL situation.

Long Term Effectiveness and Permanence

The "no action" alternative would not reduce or eliminate the potential risks involving direct contact with or ingestion of the landfill waste. Since ground-water monitoring and landfill cover inspections would not be provided, the "no action" alternative would also be ineffective in verifying that continued protection of human health and the environment is being accomplished. As a result, the "no action" alternative would have a low degree of long-term effectiveness for the protection of human health and the environment. The issue of permanence is not applicable to the "no action" alternative.

Reduction of Toxicity, Mobility, or Volume through Treatment

The "no action" alternative would not employ treatment and, therefore, would not reduce the toxicity, mobility or volume of the contaminants contained within the landfill waste material.

Short Term Effectiveness

Since on-site construction activities would not be required, the "no action" alternative would have a high degree of short-term effectiveness. This is due to the fact that the risks to human health and the environment, which were determined by the RI to be presently acceptable, would not be increased during the implementation of this alternative.

Implementability

The evaluation of implementability is not applicable to the "no action" alternative.

Costs

There are no capital or maintenance costs associated with the implementation of the "no action" alternative.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan.

5.5 ALTERNATIVE 1A: ROADWAY PLACEMENT WITH NO ACTION

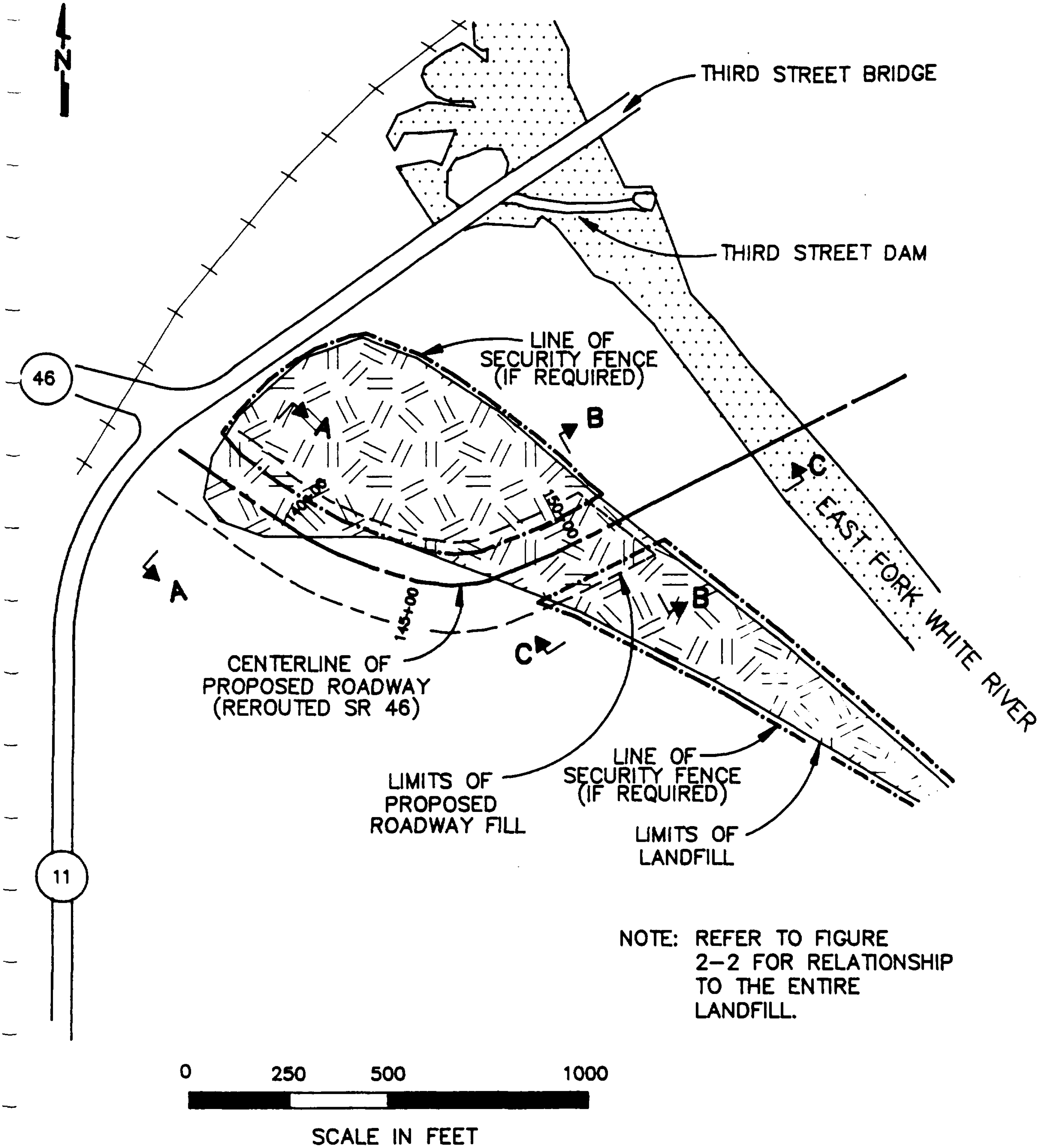
Alternative 1A is placement of the proposed roadway in combination with no remedial action.

5.5.1 Detailed Description

Placement of the proposed roadway and bridge over the OCL would constitute the only actions provided under Alternative 1A. The following detailed description addresses the intended design and construction of the proposed roadway and bridge over the OCL. The information presented was obtained from Butler, Fairman and Seufert, Inc., who serve as the roadway and bridge designer for INDOT, along with their geotechnical consultant, ATEC Associates, Inc.

The proposed rerouting of State Highway 46 places a section of the highway over the OCL. The section of the highway over the OCL would be placed on compacted roadway fill material which would be sloped up to meet the southwestern end of the proposed bridge. The proposed bridge would extend State Highway 46 over the East Fork of the White River and into the main section of the city.

Figure 5-1 presents the alignment of the proposed roadway over the OCL. The actual roadway surface would be placed on compacted roadway fill material ranging in thickness above the existing landfill surface from approximately 8 feet at the northern end of the landfill (Station 139+00) to 30 feet at the northeastern edge of the landfill (Station 150+00). This rise in the roadway fill material results in a grade for the roadway surface that ranges from +0.32 percent to +5.00 percent prior to connection with the proposed bridge. The roadway fill material would be spread out in a horizontal direction in order to adhere to a maximum side slope requirement and to evenly distribute the load on the landfill. The approximate horizontal limits of the roadway fill material are shown on Figure 5-1. Representative cross sections of the proposed roadway and bridge are shown on Figures 5-2, 5-3, and 5-4. Note that the side slopes of the roadway fill embankments, shown as three horizontal to one vertical, have yet to be finalized by the roadway designers.



NOTE: REFER TO FIGURE 2-2 FOR RELATIONSHIP TO THE ENTIRE LANDFILL.

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FIGURE 5-1
ALIGNMENT OF PROPOSED ROADWAY AND BRIDGE
OLD CITY LANDFILL
COLUMBUS, INDIANA

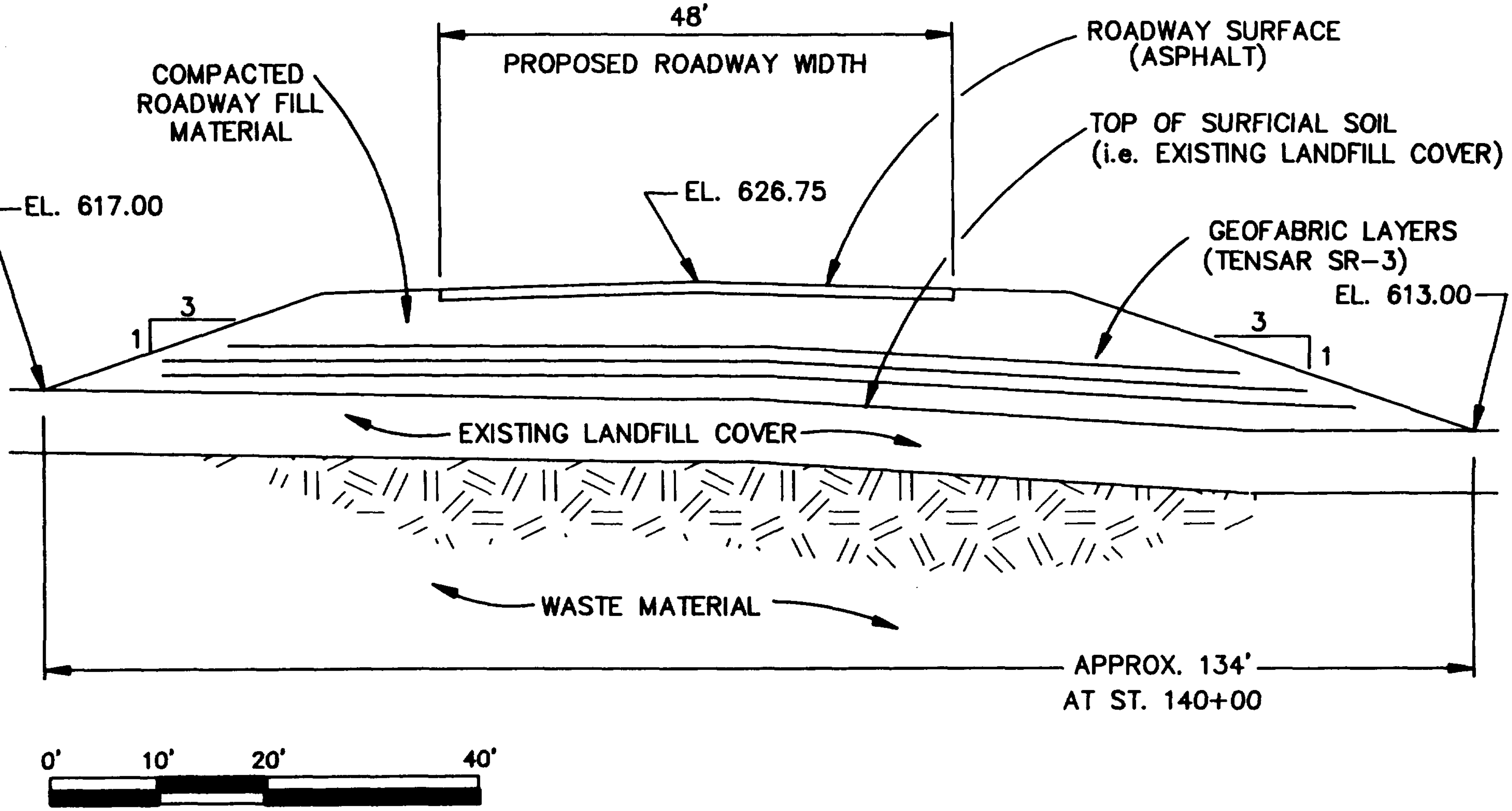

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FIGURE 5-2
PROPOSED ROADWAY & BRIDGE CROSS SECTION A-A
OLD CITY LANDFILL
COLUMBUS, INDIANA

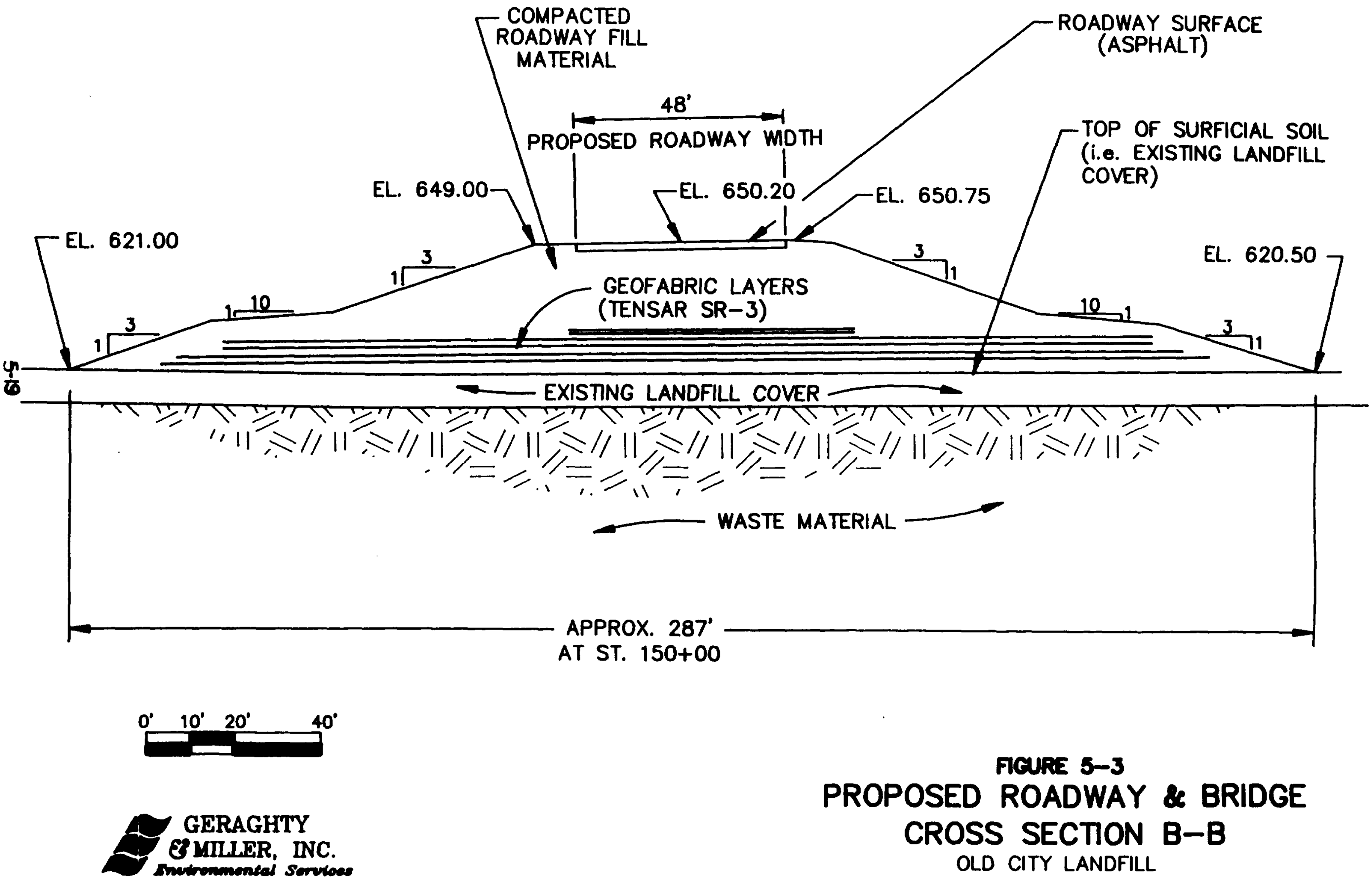

FIGURE 5-3
PROPOSED ROADWAY & BRIDGE
CROSS SECTION B-B
OLD CITY LANDFILL
COLUMBUS, INDIANA

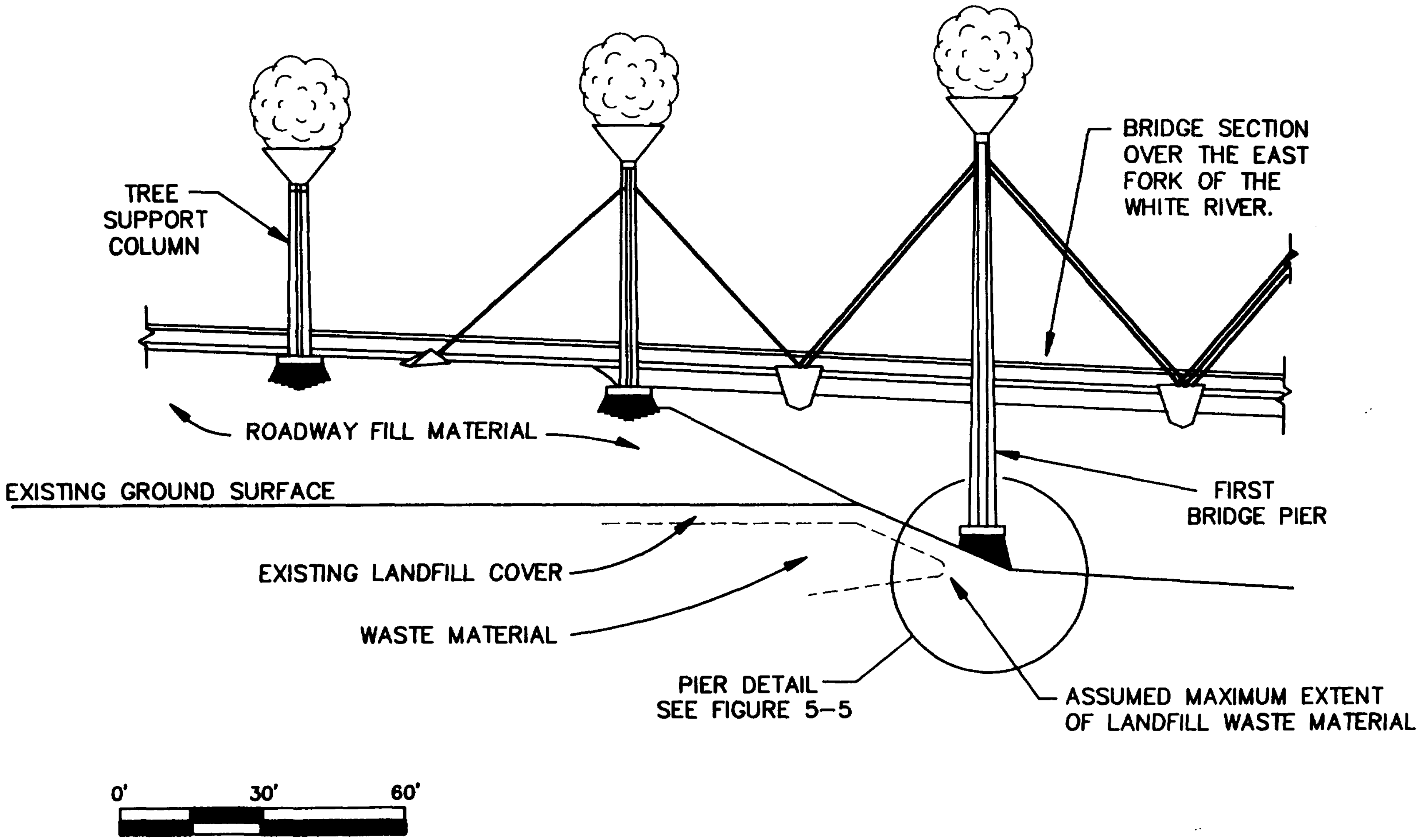

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FIGURE 5-4
PROPOSED ROADWAY & BRIDGE
CROSS SECTION C-C
OLD CITY LANDFILL
COLUMBUS, INDIANA

The initial step in constructing the proposed roadway over the OCL would be the scarification of the surficial soil that overlays the waste material. The optimal scarification process, which would function to remove vegetation and to create a smooth subbase, would be limited to the upper one foot of the surficial soil, thus, ensuring the waste material would not be exposed. To limit the dust that may be generated during scarification activities, the landfill cover will be sprayed intermittently by a fine mist of water as warranted by the existing weather conditions. It is to be noted that optimal scarification is not an absolute necessity for construction of the roadway. Scarification's main purpose is to substantially remove the vegetative matter that would have different composition and consolidation characteristics than would the roadway fill material to be placed over the existing landfill cover. Because the roadway fill material will be of sufficient depth to prevent continued plant growth and the compression of the vegetative matter will be negligible compared to the expected consolidation of the buried waste material, the extent of scarification could be reduced if there is a strong potential for uncovering buried waste material during the scarification process. Instead of removing all vegetative matter, including plant roots, the plant growth above the ground surface would simply be cut as short as possible without removing the topsoil. The final determination as to the degree of scarification to be provided would be made through consultation with the regulatory agencies and the roadway designers.

Following the scarification procedure the roadway fill material would be placed. In accordance with INDOT Standard Specifications, Section 203, the roadway fill material would consist of ordinary earth material that is free of substances that would form putrescent or deleterious deposits, or produce toxic concentrations or combinations that may be harmful to the environment. The fill would be placed in layers less than eight inches in thickness, disked or treated to break up any lumps or clods, then compacted using approved equipment. The fill would be compacted to at least 95 percent of its maximum dry density and its moisture content would be limited to within -2 and +1 percentage points of optimum. The method that will be used to determine the maximum dry density and optimum moisture content of the soil during construction is the standard Proctor method (ASTM D698-70).

The roadway fill material would be placed using standard construction equipment. In order to prevent excessive rutting of the surficial soil, which could lead to exposure of the waste material, reinforcement would be placed over the area of the landfill that would be utilized during placement of the roadway fill. Reinforcement to the existing landfill surface would be accomplished by placing 18 to 24 inches of granular material over one layer of a geogrid fabric laid out over the scarified ground surface.

The static load placed on the landfill as a result of the roadway fill material is expected to range from 1,020 pounds per square foot (psf) to 4,200 psf. The maximum dynamic load on the landfill would occur during the early stages of the roadway fill construction. Assuming a sheepsfoot roller is used, the range of dynamic pressure applied to the roadway fill material would be from 100 pounds per square inch (psi) to 200 psi. This pressure would be greatly diminished at the depth of the waste material due to the landfill reinforcement layer that would be added and the presence of the existing landfill cover (i.e. surficial soil).

As a result of the load induced by the roadway fill material, a certain degree of subsidence is expected in the waste material. Based on their previous experience with landfills, ATEC Associates estimates that the eventual subsidence may be four feet or greater. This estimate is consistent with general landfill experience which shows that medium density wastes subside approximately 10 to 20 percent of their original depth (Crawford and Smith 1985). Consistent with the heterogeneous nature of the waste material and the tapered loading from the roadway fill, the degree of subsidence would not be consistent across the line of the proposed roadway. In general, a greater degree of subsidence would be expected under the areas of the highest roadway fill material. The final degree of subsidence may be minimized due to the fact that the waste material was subjected to open burning and has undergone over twenty years of biological degradation and consolidation under its own weight. These phenomena have undoubtably reduced the amount of compressible organic matter contained in the OCL waste material.

In order to obtain settlement characteristics of the landfill waste material, a preload test has been proposed by INDOT and their consultants. The preload test program would involve placing test fills on the existing landfill cover and measuring the subsidence that would occur over time. The geotechnical and environmental aspects of conducting a preload test at the OCL are addressed in a previous document submitted to the USEPA by G&M (G&M 1990b) on the behalf of the respondent PRPs and, thus, will not be addressed in this report. The preload test document will be made part of the administrative record. If conducted, results of the preload test will be summarized in a technical supplement to the feasibility study which would be made available prior to the selection of a remedy for the OCL.

To account for the possible uneven distribution of subsidence across the roadway fill area, a geogrid fabric layer would be incorporated into the roadway fill construction. The geogrid fabric layer, which would include multiple geogrid mats vertically spaced approximately 12 inches apart, would function to prevent shear failures from occurring by resisting uneven settlement of the roadway fill material. The geogrid fabric would run the full length of the roadway fill material and would be located as shown on Figures 5-2 and 5-3.

The roadway itself would consist of four 12 feet wide travel lanes. The roadway would be bordered by 11 feet wide shoulders on each side. The roadway pavement and shoulder would consist of asphalt on an aggregate base. A 10 inch high concrete curb would be placed along the outside edge of each shoulder. The architectural plans call for a series of aboveground concrete planter boxes, spaced at 70 foot intervals, to be constructed on the roadway fill sideslopes behind the curb line. These boxes would contain dwarf pear trees. Approximately one-half of these planter boxes would be mounted on concrete pedestals that would vary in height from 2 to 45 feet. A planter box placed on top of a 75 feet high concrete column would be constructed on each side of the roadway at Station 139+22. Each of the concrete columns would be supported by spread footings located in the roadway fill material and would not extend downward into the existing landfill cover or the waste material.

As shown on Figure 5-4, the first bridge pier would be located immediately adjacent to the assumed lateral extent of the waste material along the northeastern edge of the landfill. The position of the first bridge pier, which would be approximately 90 feet in width, was established based on the architectual requirement for incremental spacing of the bridge piers across the river and in an effort to avoid placement within the waste material. This spacing pattern is an integral part of the structural design of the bridge and also provides aesthetic benefits. Although the bridge pier itself is intended to be located outside the limits of the waste material, excavation required for the construction of the bridge pier foundation may potentially lead to the exposure of a small area of waste material.

In order to install the support footing for the first bridge pier, a cofferdam consisting of steel sheet piling would have to be constructed around the location of the bridge pier. This cofferdam would be approximately 96 feet long by 17 feet wide and extend downward to a minimum elevation of 595.00. Figure 5-5 illustrates the expected relationship between the bridge pier, cofferdam, and the assumed lateral extent of the waste material.

Prior to placing the sheet piling for the cofferdam, the soil within and immediately surrounding the location of the cofferdam that is above elevation 609.00 would be excavated. Continual visual examination would be conducted during this excavation process to determine if any waste material is uncovered. If waste material is uncovered during this excavation, then

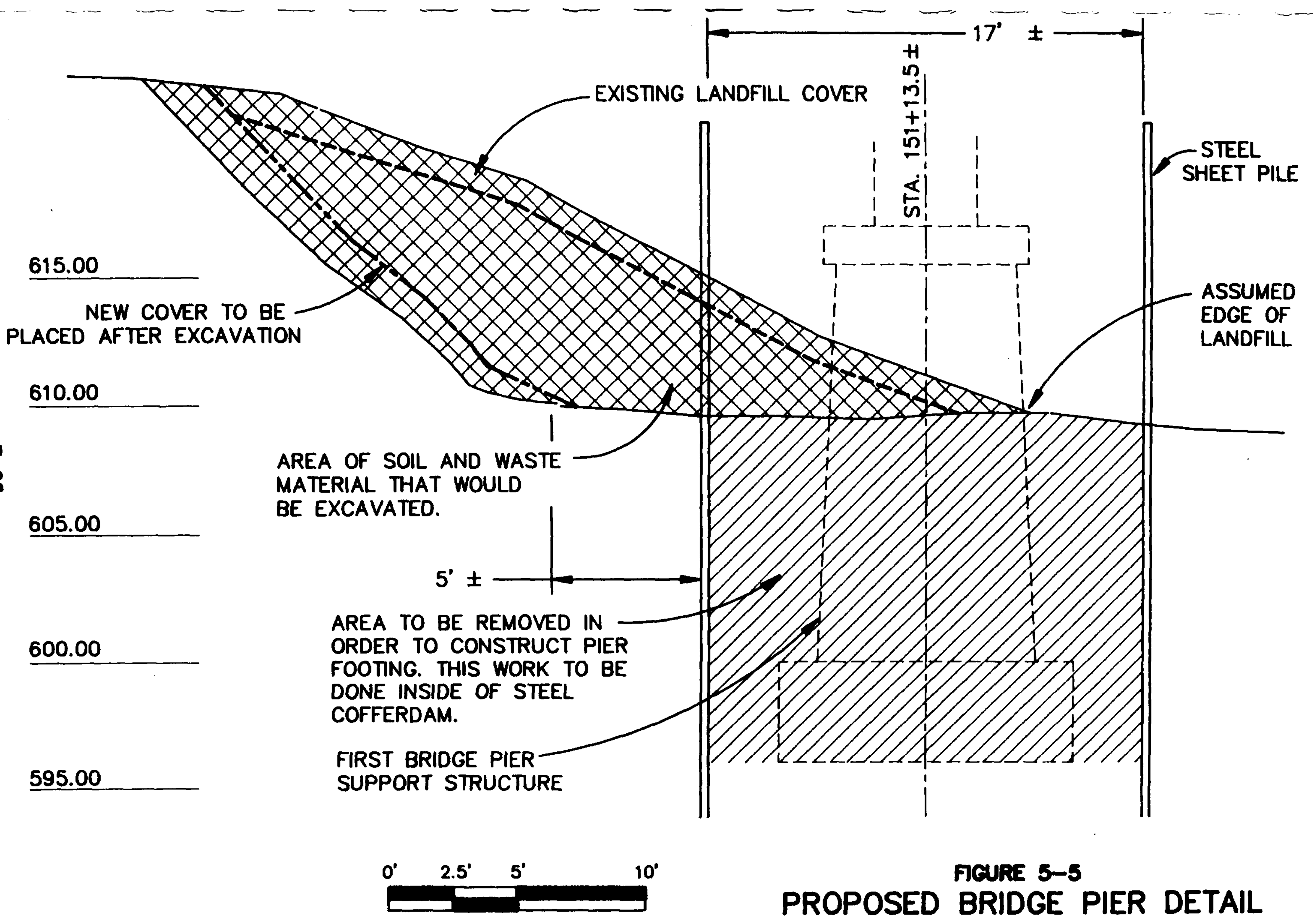

FIGURE 5-5
PROPOSED BRIDGE PIER DETAIL AT EDGE OF LANDFILL
OLD CITY LANDFILL
COLUMBUS, INDIANA

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removal would continue until the bottom of the waste material would be reached. If waste material would be exposed along the southwestern edge of this excavation, it would be immediately covered by compacted clay which in turn would be covered by plastic sheeting. Following completion of the cofferdam, the excavated area outside the cofferdam would be completely backfilled with compacted clay in order to ensure the continued integrity of the existing landfill cover. The excavated area inside the cofferdam above elevation 609.00 would also be backfilled with compacted clay following the completion of the bridge pier and removal of the sheet piling. The entire area of compacted clay backfill would then be covered with top soil and seeded to match the existing vegetation.

It is anticipated that approximately 76 cubic yards of soil would need to be excavated above elevation 609.00 in order to construct the cofferdam (reference Figure 5-5). Of this volume, it is estimated that only 0 to 20% would be buried waste material. Any excavated waste material would be shipped off-site for disposal at either a RCRA permitted landfill or a non RCRA permitted landfill. The determination of which landfill disposal option is required would be made after performing toxicity characteristic analyses on samples from the excavated waste material. The excavated soil below elevation 609.00 is not expected to contain any waste material and thus could be used as standard backfill. This, however, would be confirmed during visual inspection of the excavation. While the toxicity characteristic analyses are being performed, the excavated waste materials will be temporarily stored on-site in roll-off boxes. The integrity of these roll-offs will be assessed prior to depositing any waste materials in them, and they will be regularly inspected to ensure that there are no spills or leaks of waste materials, or that the integrity of the roll-offs is breached. The temporary storage of the excavated waste material would be in full accordance with the requirements of 329 IAC 3-48.

In order to provide proper construction conditions for the first bridge pier, it is intended for the cofferdam to be essentially water tight upon its completion. However, prior to the completion of the cofferdam and perhaps during construction of the first bridge pier, ground-water recovery would be required for the excavation. As a precautionary measure, it is intended that the recovered ground water would be pumped to a tanker truck for eventual discharge to the POTW. The volume of ground water that would have to be recovered can not be accurately predicted at this time. The final procedure for handling and discharging the recovered ground water would be established based on consultation with the regulatory agencies and the results of ground-water monitoring.

The work involved with constructing the bridge pier, as well as all other on-site activities would be conducted in accordance with the health and safety plan developed for the OCL (G&M 1987). Air sampling and the use of respiratory protective equipment would be implemented as the situation dictates. Any work potentially requiring excavation in to the waste material would be done under the supervision of a health and safety officer experienced in hazardous waste remedial projects. Excavation work would be done with mechanical means so as to preclude any of the construction workers coming in direct contact with the waste material, should any waste be exposed. Additionally, should any drums be uncovered during the excavation work they would be handled, placed in a secure area with appropriate containment features, sampled, and disposed of in accordance with the procedures presented in the USEPA document Guidance Document for Cleanup of Surface Tank and Drum Sites, May, 1985. The on-site supervisor of excavation activities would be provided a copy of this document.

After finishing the construction of the roadway, the roadway fill would be seeded with a mixture consisting of various Kentucky bluegrasses. The architectural plans call for approximately three acres surrounding the roadway fill material to be covered with flowers and trees with roots extending no more than 16 inches below finished ground elevation. An above ground irrigation system would be used to water the plants and trees.

The existing drainage patterns would be maintained as much as possible. The area of the OCL that would be covered by the proposed roadway is currently graded such that all drainage runs southward, away from the river into the cultivated fields to the southwest of the landfill. The proposed roadway fill would act as a dam across this drainage area. To alleviate this situation, a culvert would be placed under the roadway at the resulting low point of the landfill. No ditching or any other method of concentrating runoff would be used. The culvert would simply provide an opening for runoff that currently follows the existing swale. Prior to final design, however, an assessment would be made on how the roadway would impact the degree to which infiltration would affect the landfill. If through consultation with the regulatory agencies it is determined that mitigation measures should be implemented to minimize infiltration, then proper mitigation measures, such as a series of drainage culverts, would be incorporated as part of the roadway design.

To allow for subsidence in the landfill waste material, the roadway construction schedule would require that the roadway fill material be placed a minimum of six months prior to construction of the roadway surface and the bridge connection. This time frame would ensure that most of the subsidence would occur prior to placement of the roadway surface and bridge connection.

5.5.2 Assessment

The results of assessing Alternative 1A against the evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The evaluation presented in Section 5.4.2 concluded that the "no action" alternative, Alternative 1, would not limit any increased risks to human health and the environment that would exist with any future releases of contaminants from the OCL. This conclusion also applies to the evaluation of Alternative 1A; however, there would be a greater chance for contaminant releases to occur than Alternative 1 due to placement of the roadway. Adequate steps would be taken during construction of the roadway and bridge to ensure the existing landfill cover would not be disturbed. However, by loading and compacting the waste material, there would be a greater potential for the generation of leachate. This leachate could lead to seep formation at the toe of the landfill and/or cause releases of contaminants into the underlying ground water. Without any inspection and monitoring controls which could trigger appropriate remedial action, Alternative 1A would not ensure the overall protection of human health and the environment.

Compliance with ARARs

All chemical-specific ARARs are being met for the environmental media at the OCL. With the aforementioned potential for leachate generation it is possible that chemical-specific ARARs could be exceeded some time in the future. All roadway and bridge construction activities would comply with all identified construction related action-specific and location-specific ARARs for this alternative. However, as with Alternative 1, Alternative 1A would not comply with any remedial related action-specific requirements that are applicable or relevant and appropriate to the OCL situation. Consistent with the explanation presented in Section 5.4.2, Alternative 1A would not need to comply with remedial related action-specific ARARs unless a remedial action is necessary as a result of the roadway placement. In this case, Alternative 1A would comply with all ARARs that are triggered as a result of the need for remediation created by the construction of the roadway.

Long-Term Effectiveness and Performance

The determination that the "no action" alternative, Alternative 1, would have a low degree of long-term effectiveness for the protection of human health and the environment would also apply to Alternative 1A. The low degree of long-term effectiveness results from not limiting the potential for direct contact with the waste material and not providing monitoring and inspection to ensure contaminant releases are not occurring. The issue of permanence is not applicable since no remedial action would be implemented.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1A would not employ treatment to reduce the toxicity, mobility or volume of the contaminants contained within the landfill waste material.

Short-Term Effectiveness

Alternative 1A would have a moderately low degree of short-term effectiveness. Since the current risks to human health and the environment associated with the OCL are within acceptable health-based and environmental quality-based guidelines, any action, either remedial or roadway construction related, that would disturb or expose the waste material, could potentially jeopardize the short term protection of human health and the environment. Although all construction related action-specific ARARs (i.e., soil handling, waste excavation, waste disposal, etc.) would be met in constructing the roadway, an increased potential for contaminant releases would exist during placement of the roadway. In addition, construction of the roadway would potentially cause an increase in traffic accidents in the area surrounding the OCL due to the truck traffic required to haul materials to the site.

Implementability

The roadway and bridge would be constructed utilizing standard construction equipment and practices. Activities required to excavate and dispose of isolated areas of waste material (i.e. the area near the first bridge pier) and to minimize disturbance of the existing landfill cover could be readily implemented.

Costs

There are no capital or maintenance costs associated with remedial action for Alternative 1A. Although a portion of the waste material near the first bridge pier may have to be excavated and disposed of, the cost for this activity is not considered applicable to the remediation of the OCL. The cost for constructing the roadway and bridge is also not considered relevant to the OCL FS because it is not part of a remedial action. It should be noted, however, that the roadway and bridge would need to be compatible with any remedial action deemed necessary for the OCL.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan. It is anticipated, however, that the community is in strong support of the proposed roadway and bridge for it would represent a major civic development for the City of Columbus.

5.6 ALTERNATIVE 2: INSTITUTIONAL CONTROLS

Alternative 2 represents the "institutional controls" alternative consisting of access restrictions, deed restrictions, landfill cover maintenance and ground-water monitoring.

5.6.1 Detailed Description

Alternative 2 would consist of four distinct actions that would be implemented to ensure the continued protection of human health and the environment. Access restrictions would prevent access to the site by unauthorized personnel as well as the wildlife that inhabits the surrounding environment. Deed restrictions would prevent future land use of the site area and would prohibit placement of ground-water wells within a prescribed radius of the site. Landfill cover maintenance would ensure the continued integrity of the existing landfill cover. Finally, ground-water monitoring would denote any variations in ground-water quality and, thus, dictate whether future remediation efforts would be warranted.

Access restrictions would be provided by the installation of a fence surrounding the landfill area. It is envisioned that a 6 feet high chain link fence with 3 strands of barbed wire along its top would be used as the perimeter fence. A sufficient number of warning signs would be placed along the perimeter fence.

Deed restrictions would be initiated by the local authorities and would be recorded in the appropriate registry of deeds. Deed restrictions would control any future land development of the OCL site. In addition, deed restrictions would prevent the current use or future placement of ground-water wells within a prescribed radius of the OCL site.

A maintenance program would be implemented in order to maintain the existing landfill cover. This program would include maintaining a full, competent vegetative layer and semi-annual inspection of the cover to ensure excessive erosion or leachate seep formation are not occurring. If excessive erosion or leachate seeps are detected, then the existing landfill cover would be repaired by the placement of compacted clay and top soil over the damaged area.

A ground-water monitoring program would be implemented to identify and quantify any contaminant releases that may occur from the landfill waste material. The specifics of the program would have to be approved by the regulatory agencies; however, it is anticipated that the program would follow the State of Indiana's sanitary landfill post-closure ground-water monitoring requirements identified under 329 IAC 3-45. It is assumed that, at a minimum, one existing upgradient monitoring well and three existing downgradient monitoring wells would be sampled semi-annually during the course of the required monitoring period. Each round of ground-water sampling data would be analyzed to determine whether a statistically significant increase over background values has occurred for any of the constituents of concern. The specifics pertaining to the statistical analysis and constituents of concern would be similar to the ground-water monitoring procedures presented in the USEPA-approved Environmental Monitoring and Contingency Plan (G&M 1990b). Although the procedures in the Plan only apply to the ground-water monitoring required as part of the landfill loading testing program, they could be modified to represent long-term ground-water monitoring procedures. The length of time in which the ground-water monitoring program would have to be carried out would be established by the regulatory agencies. In accordance with CERCLA Section 121(c), a formal review of the ground-water quality data would be conducted by USEPA within five years of the implementation date in order to verify the effectiveness of the remediation effort.

If it were to be determined from the ground-water monitoring program that the ground water had become adversely impacted by contaminant releases from the OCL, then ground-water cleanup and/or control actions would be implemented. The regulatory agencies, in consultation with the PRPs, would determine the necessary ground-water actions required consistent with the requirements of the NCP. If required, ground-water cleanup would involve collecting the ground water via a series of recovery wells and transmitting the collected ground water to the Columbus POTW for treatment. For this scenario, it is assumed that any ground water that may have to be collected in the future would have constituent concentrations below the sewer discharge limits (i.e. pretreatment limits) set forth by the City of Columbus. The City of Columbus pretreatment limits are listed in Table 5-2. However, if this assumption is not correct (i.e. the ground water does not meet the existing pretreatment limits), then a contingency plan would be implemented. The contingency plan, which identifies what steps would need to be taken to pretreat the recovered ground water prior to discharging to the POTW, is outlined in the aforementioned approved Environmental Monitoring and Contingency Plan (G&M 1990b).

The "Environmental Monitoring and Contingency Plan for Landfill Loading Activities" (G&M 1990b) that has been previously submitted as part of the aforementioned preload test proposal presents a more detailed description of the steps required to determine the necessity of ground-water recovery and how the recovery system would be implemented. Although this information pertains specifically to ground-water recovery that may be required as a result of the preload testing or placement of the roadway, the principles also apply to site wide ground-water monitoring, establishment of response levels, and implementation of a recovery system.

5.6.2 Assessment

The results of assessing Alternative 2 against the nine evaluation criteria are presented below.

Table 5-2: Pretreatment Limits for Discharge to the Columbus POTW, Columbus, Indiana

The following limits apply to liquid waste streams discharged to the City of Columbus sanitary sewer system. There are currently no flow rate limits placed on discharges to the sanitary sewer system

Chemical Constituent/Parameter	Discharge Limit (1)
Biochemical Oxygen Demand	344
Suspended Solids	248
Total Phosphorus	11.0
Ammonia Nitrogen	27.0
pH	6-9
Oil & Grease (Total)	100
Copper	4.0
Chromium	5.0
Nickel	5.0
Cadmium	1.0
Lead	2.0
Zinc	5.0
Cyanide	1.0
Phenol	2.0
Iron	50.0
Arsenic	1.0
Mercury	0.5

Notes: (1) All limits are expressed in milligrams/liter except pH

Overall Protection of Human Health and the Environment

As stated previously, the risks to human health and the environment associated with the existence of the OCL, in its present condition, are within acceptable health-based and environmental quality-based guidelines. Since the condition of the OCL is expected to remain unchanged over the coming years, it is unlikely that significant releases of contaminants, if any, will occur from the landfill waste material. As a result, it is expected that the risks to human health and the environment associated with the continued, unchanged existence of the OCL would continue to fall within acceptable health-based and environmental quality-based guidelines. Implementation of institutional controls, however, would further ensure the continued protection of human health and the environment.

A perimeter fence would be effective in preventing unauthorized personnel from entering the site, thus, eliminating the potential for accidental dermal contact with or ingestion of the landfill material. A perimeter fence, however, would not be effective in preventing birds and other small animals from potentially coming in contact with the landfill waste material.

Deed restrictions would be effective in controlling any future land use in which human health and the environment might be jeopardized. Deed restrictions would also be effective in preventing any future use of potentially affected ground water by preventing the installation of wells within a prescribed radius of the site.

Ground-water monitoring would detect any future contaminant releases, if they were to occur, so that potential impacts to human health and the environment could be assessed and future remediation efforts could be appropriately developed.

Due to the competent vegetative growth that extends over the full area of the existing landfill cover layer, it is unlikely that significant erosion would occur, even during a major flooding event, such that the landfill material would become exposed. The landfill cover maintenance program would ensure that the existing cover is not subjected to excessive erosion.

Since Alternative 2 would not provide for enhanced source control it is possible, although unlikely, that significant releases of contaminants from the landfill waste material could occur some time in the future. However, since the ground-water monitoring program would detect any contaminant release that may occur prior to the release entering a viable exposure pathway, adequate future remedial action could be implemented to abate any potential risks to human health and the environment. Since the current risks to human health and the environment are within acceptable limits, and since provisions would be implemented to ensure that proper remedial action could be taken if significant releases of contaminants were to occur in the future, Alternative 2 would provide a high degree of protection to human health and the environment.

Compliance with ARARs

At the present time, all chemical-specific ARARs are being met for the environmental media at the OCL. Unless significant releases of constituents were to occur, although unlikely, some time in the future, all chemical-specific ARARs would continue to be met. Alternative 2 would also comply with all identified action-specific and location-specific ARARs that apply to its remediation activities.

Since the OCL operated primarily as a municipal landfill, the Indiana sanitary landfill closure requirements are relevant to this alternative. The basic purpose of the Indiana sanitary landfill closure requirements are to ensure that the buried waste material is safely contained to prevent contaminant migration and to verify the adequacy of containment by performing periodic environmental monitoring. Based on the results of the RI, it is possible that the existing landfill cover provides adequate containment of the waste material, even though all aspects of the Indiana sanitary landfill closure requirements, such as the allowable slopes (2 to 33%) for the surface of the landfill cover, are not fully met.

Long-Term Effectiveness and Permanence

The long-term risks to human health and the environment associated with Alternative 2 involve the potential, although unlikely, significant release of contaminants from the landfill waste material into the underlying ground water as well as the potential for surface exposure of the contaminants. Since the existing landfill cover would prevent the surface exposure of the waste material, contaminant release to the ground water represents the only significant exposure pathway associated with the OCL. However, by monitoring the ground-water quality, any significant releases of contaminants into the ground water would be detected. Due to the relatively slow ground-water velocity in the underlying aquifer, a more than adequate time frame would exist in which adequate remedial actions could be taken if significant releases of contaminants were to occur.

The major factor that would thus impact the long-term effectiveness and permanence of Alternative 2 is the adequacy and reliability of ground-water monitoring. If conducted by properly trained personnel, ground-water monitoring is a very effective and reliable means for establishing ground-water quality. To ensure the accuracy of the ground-water monitoring program, adequate quality assurance/quality control measures would have to be taken during the sampling, transporting, and analysis of the ground-water samples. In addition, both the perimeter fence and the deed restrictions would offer a high degree of long-term effectiveness and permanence in preventing site access and potentially unsafe land usage and ground-water utilization.

Reduction of Toxicity, Mobility, or Volume through Treatment

The institutional controls provided under Alternative 2 would not employ treatment and, therefore, would not reduce the toxicity, mobility or volume of the contaminants contained within the landfill waste material.

Short-Term Effectiveness

The only on-site construction activities that would be provided as part of Alternative 2 would be the installation of the perimeter fence. Since the location of the perimeter fence would be outside the limits of the landfill material placement, worker safety would not be impacted by the presence of any contaminants contained within the landfill waste material. Upon installation of the perimeter fence and initiation of the ground-water monitoring program, the remedial response objectives would be met.

Implementability

A perimeter fence, ground-water monitoring program, and landfill cover maintenance program could all be easily implemented. Deed restrictions could also be easily implemented; however, it would require the assistance of local government officials.

If the ground-water monitoring program would detect significant releases of contaminants from the landfill material, any future remedial action required to abate the resultant risks to human health and the environment could be readily implemented. The conceptual design of a ground water recovery system has already been prepared in the event that ground-water response actions are required as a result of the landfill preload testing program. The conceptual design is presented in the approved Environmental Monitoring and Contingency Plan (G&M 1990b).

Costs

The capital costs associated with implementing Alternative 2 are estimated to be $160,000. The annual O&M costs associated with Alternative 2 are estimated to be $45,000. By applying a 5% discount rate over a 30 year implementation period the total present worth associated with Alternative 2 is estimated to be $852,000. A summary of the cost estimates for Alternative 2 is presented in Table 5-3.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan.

5.7 ALTERNATIVE 2A: ROADWAY PLACEMENT WITH INSTITUTIONAL CONTROLS

Alternative 2A would combine placement of the proposed roadway with institutional controls as the remedial action.

Table 5-3. Cost Analysis of Alternative 2 for the Old City Landfill, Columbus, Indiana

The following cost estimates apply to Alternative 2 which consists of Institutional Controls.

CAPITAL REQUIREMENTS	COST
Industrial Chain Link Fence - 6' high (6,750 ft @ $15.50 L.F.)	$ 105,000
Gates and Fence Accessories (Gates, Corner Posts, Braces)	$ 13,000
Deed Restrictions	$ 10,000
Subtotal	$ 128,000
Engineering (10%)	$ 13,000
Contingency (15%)	$ 19,000
TOTAL CAPITAL COST	**$ 160,000**
ANNUAL O & M REQUIREMENTS	
Cover Inspection and Maintenance	$ 20,000
Ground-Water Monitoring	$ 20,000/year
Fence Inspection and Maintenance	$ 5,000/year
ANNUAL O & M COST	**$ 45,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate)	**$ 852,000**

5.7.1 Detailed Description

Placement of the roadway would be accomplished as previously described in Section 5.5.1. The institutional controls previously described in Section 5.6.1 for Alternative 2 would be implemented as the means for meeting the remedial response objectives. Since detailed descriptions of the proposed roadway and the institutional controls have been given previously, they will not be repeated here. Except as noted below, all aspects of the proposed roadway and institutional controls would be as previously described in the above noted sections.

Due to the increased potential for leachate generation that would result from placement of the roadway, additional provisions would be added to the institutional controls in order to ensure the continued protection of human health and the environment. During and following placement of the roadway fill material, routine inspections would be made to verify that leachate seeps have not formed along the toe of the landfill. These inspections would be more frequent than those discussed in Section 5.6.1. If leachate seeps were to develop, immediate response actions would be taken to contain the leachate. The leachate containment actions would most likely involve covering the leachate seep with compacted clay and top soil that would contain an integral drain tile to collect the leachate.

Although the current conditions do not necessitate implementation of ground-water cleanup and/or control actions, the increased potential for leachate generation may cause contaminant releases into the underlying ground water. In order to adequately monitor for contaminant releases during the period of potentially enhanced leachate generation, the ground-water monitoring program discussed in Section 5.6.1 would be expanded. Additional monitoring wells and an increased sampling frequency have been proposed to properly monitor the ground water during and following placement of the proposed roadway. The required number and location of the monitoring wells and the appropriate sampling frequency are identified in the "Environmental Monitoring and Contingency Plan for Landfill Loading Activities" (G&M 1990b) which was submitted for agency review on September 10, 1990.

An additional measure of ground-water protection would be provided by the development of a ground-water recovery system contingency plan. The proposed ground-water recovery system contingency plan comprises a portion of the aforementioned "Environmental Monitoring and Contingency Plan for Landfill Loading Activities." The contingency plan, which would serve as the blueprint for a ground-water recovery system, would identify and describe what actions would need to be taken in order to adequately collect and treat any adversely impacted ground water. Key aspects of the contingency plan would include identifying the number and location of the recovery wells required to contain and collect the ground water, the means for discharging the collected ground water to the Columbus POTW, and the schedule of implementation necessary to ensure any adversely impacted ground water does not endanger public health and the environment. The plan would include sufficient design information so that the recovery system could be readily installed if it were determined that ground-water response actions were warranted.

5.7.2 Assessment

The results of assessing Alternative 2A against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The assessment of institutional controls presented in Section 5.6.2 concluded that they would be very effective for the OCL in further ensuring the continued protection of human health and the environment. This assessment also applies for the institutional controls provided under Alternative 2A.

Since steps would be taken to reinforce the existing landfill cover, the waste material would not become exposed during placement of the roadway. However, as discussed in Section 5.5.1, despite design efforts to avoid exposing the buried waste material, a small volume of waste material may need to be excavated near the first bridge pier. Proper excavation, storage, and diposal steps, also discussed in Section 5.5.1, would be taken to prevent exposure to, and releases of, any contaminants contained in the excavated waste material. The main environmental concern associated with placement of the roadway on the OCL would, thus, be the potential for enhanced leachate generation.

By incorporating a comprehensive leachate seep inspection and ground water monitoring program, Alternative 2A would ensure that proper remedial response action could be taken to abate any contaminant releases. To minimize the migration of any contaminants released from the OCL, the leachate seep inspections and ground-water sampling events would be done at frequent intervals and the ground-water recovery system contingency plan would be available should ground-water response actions be warranted. As a result, Alternative 2A would provide a high degree of overall protection to human health and the environment, even though it would include placing the roadway on top of the landfill.

Compliance with ARARs

At the present time, all chemical-specific ARARs are being met for the environmental media at the OCL. With the potential for enhanced leachate generation, it is possible that chemical-specific ARARs could be exceeded some time in the future; however, control measures would be implemented to ensure that these elevated chemical concentrations would be limited to the on-site environmental media (i.e., off-site migration would be prevented). The roadway and bridge construction activities along with the institutional controls would comply with all pertinent action-specific and location-specific ARARs. The detemination that Indiana sanitary landfill closure requirements are not appropriate for Alternative 2, which was presented in Section 5.6.2, also applies to Alternative 2A.

Long-Term Effectiveness and Permanence

The assessment of institutional controls relative to long-term effectiveness and permanence that was presented in Section 5.6.2 also applies to the institutional controls provided under Alternative 2A. This previous assessment concluded that access and deed restrictions, landfill cover maintenance, and ground-water monitoring would offer a high degree of long-term effectiveness and permanence. The placement of the roadway over the OCL would not reduce the long-term effectiveness and permanence of institutional controls since additional measures, such as periodic leachate seep inspections and the development of a ground-water recovery system contingency plan, would be enacted to address the environmental issues associated with the proposed roadway.

Reduction of Toxicity, Mobility, or Volume through Treatment

The institutional controls provided under Alternative 2A would not employ treatment to reduce the toxicity, mobility, or volume of the constituents contained within the landfill waste material.

Short-Term Effectiveness

As stated in Section 5.5.2, any on-site action, either remedial or construction related, may potentially increase the short-term risks to human health and the environment. This is due to the fact that the risks associated with the OCL in its present condition are within acceptable health-based and environmental quality-based guidelines. Although proper precautions, such as reinforcement of the existing landfill cover, would be taken, there still would exist a potential for contaminant releases to occur during construction of the roadway and bridge. In addition, construction of the roadway would potentially cause an increase in traffic accidents in the area surrounding the OCL due to the truck traffic required to haul materials to the site. As a result, Alternative 2A would have a moderately low degree of short-term effectiveness. Upon implementing access and deed restrictions and upon initiation of the ground-water monitoring program the remedial response objectives would be met.

Implementability

The institutional controls provided for Alternative 2A could all be readily implemented and easily incorporated with the design and construction of the roadway and bridge.

Costs

The capital costs associated with implementing the institutional controls for Alternative 2A are estimated to be $260,000. This cost estimate is higher than that for Alternative 2 because it reflects the potential for additional ground-water monitoring wells and the development of a ground-water recovery system contingency plan. The annual O&M costs associated with Alternative 2A are estimated to be $75,000. By applying a 5% discount rate over a 30 year implementation period, the total present worth associated with Alternative 2A is estimated to be $1,413,000. A summary of the cost estimates for Alternative 2A is presented in Table 5-4.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan. It is antipated, though, that the community is in strong support of the proposed roadway and bridge for it would represent a major civic development for the City of Columbus.

5.8 ALTERNATIVE 3: SANITARY LANDFILL CAP

Alternative 3 would consist of placing a sanitary landfill cap over the existing landfill surface. The institutional controls identified for Alternative 2 in Section 5.6.1 would also be provided under Alternative 3.

5.8.1 Detailed Description

The major aspect of alternative 3 would be the placement of an engineered sanitary landfill cap over the surface of the OCL. The engineered sanitary landfill cap would be designed and constructed in accordance with 329 IAC 2-14-19, which describe Indiana's closure requirements for sanitary landfills. The function of the sanitary landfill cap would be to limit

Table 5-4. Cost Analysis of Alternative 2A for the Old City Landfill, Columbus, Indiana

The following cost estimates apply to Alternative 2A which consists of Roadway Placement and Institutional Controls. Costs for the roadway are not included.

CAPITAL REQUIREMENTS	COST
Industrial Chain Link Fence - 6' high (6,750 ft @ $15.50 L.F.)	$ 105,000
Gates and Fence Accessories (Gates, Corner Posts, Braces)	$ 13,000
Deed Restrictions	$ 10,000
Development of Ground-Water Recovery System Implementation Plan (includes Analytical Modelling and Preliminary Design)	$ 40,000
Additional Monitoring Wells (8 Wells)	$ 40,000
Subtotal	$ 208,000
Engineering (10%)	$ 21,000
Contingency (15%)	$ 31,000
TOTAL CAPITAL COST	**$ 260,000**
ANNUAL O & M REQUIREMENTS	
Cover Inspection and Maintenance	$ 20,000
Ground-Water Monitoring	$ 50,000/year
Fence Inspection and Maintenance	$ 5,000/year

(continued on next page)

Table 5-4. Cost Analysis of Alternative 2A for the Old City Landfill, Columbus, Indiana

The following cost estimates apply to Alternative 2A which consists of Roadway Placement and Institutional Controls. Costs for the roadway are not included.

ANNUAL O & M COST	**$ 75,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate; not including the cost of roadway)	**$1,413,000**

the amount of water infiltration that passes down through the landfill waste material and to provide an additional barrier in order to prevent surface exposure of, and direct contact with, the waste material.

In accordance with the aforementioned regulations, the sanitary landfill cover would consist of at least two feet of compacted clay overlaid by at least six inches of topsoil. There are no permeability requirements identified in the Indiana regulations; however, properly compacted clay can usually provide an hydraulic conductivity of less than 1×10^{-7} cm/sec. The topsoil layer would be seeded to provide a full vegetative cover over the landfill cap.

In order to promote drainage runoff while minimizing the potential for erosion, the top slopes of the cover would be set at 4%, while the side slopes of the cover would be sloped at 33%. These slopes are within the limits required by 329 IAC 2-14-19. The landfill cover would extend a few feet beyond the extent of the buried landfill waste material along the entire periphery of the landfill. The assumed extent and slope configuration of the sanitary landfill cap is shown in Figure 5-6. A typical cross section of the sanitary landfill cap is shown in Figure 5-7.

To account for the additional surface drainage that would result from the reduced permeability of the landfill cover, a drainage collection ditch would be placed along the perimeter of the landfill cap. This collection ditch would be sloped to allow the collected runoff to flow by gravity to a discharge channel into the East Fork of the White River. It is likely that an NPDES permit would be required for this direct discharge, consistent with 327 IAC 5-4-6.

The initial step in constructing the sanitary landfill cap would be to scarify the existing landfill cover in order to remove the existing vegetation. Section 5.5.1 stated that the scarification process required as part of Alternative 1A for the area underlying the roadway fill,

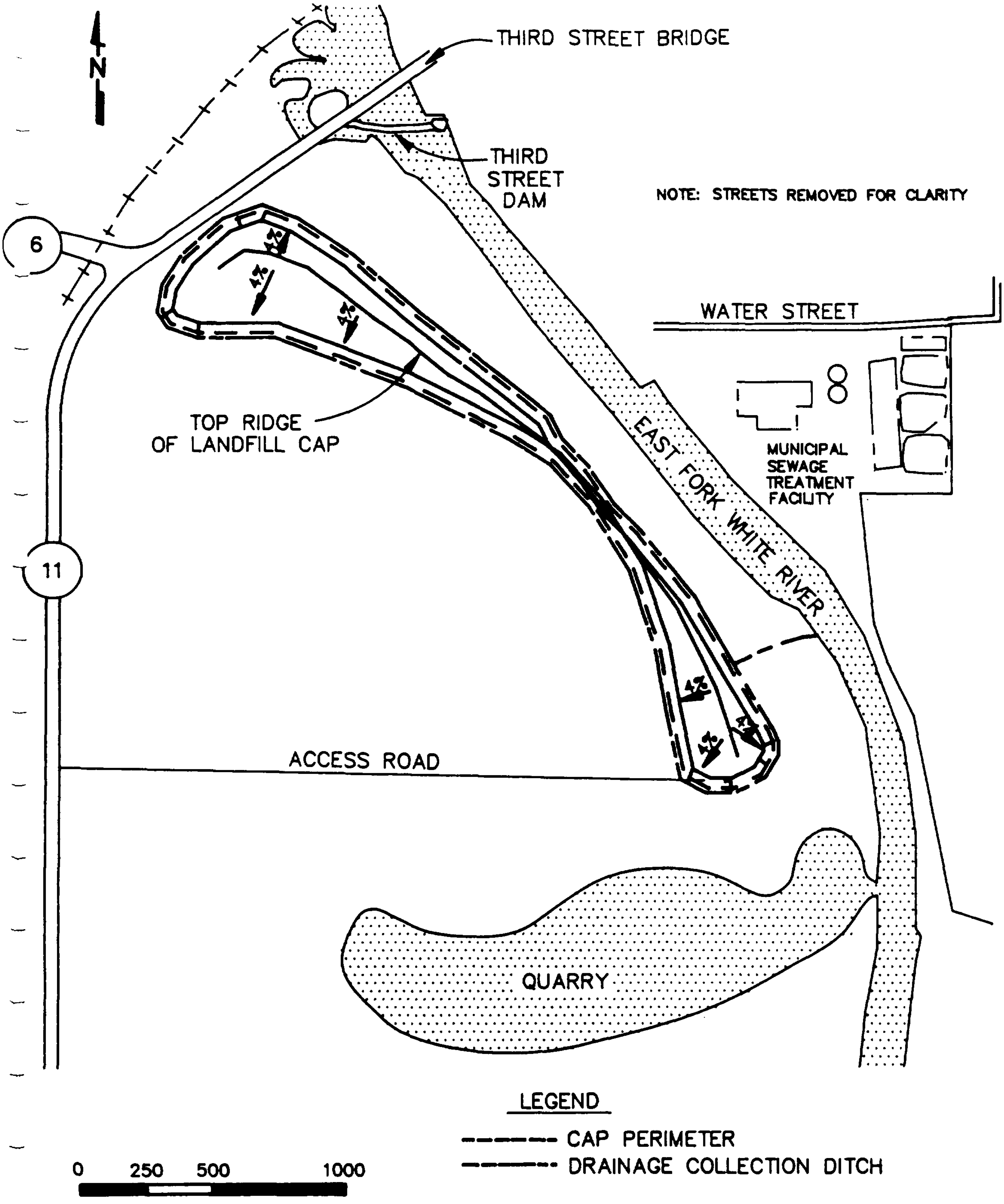

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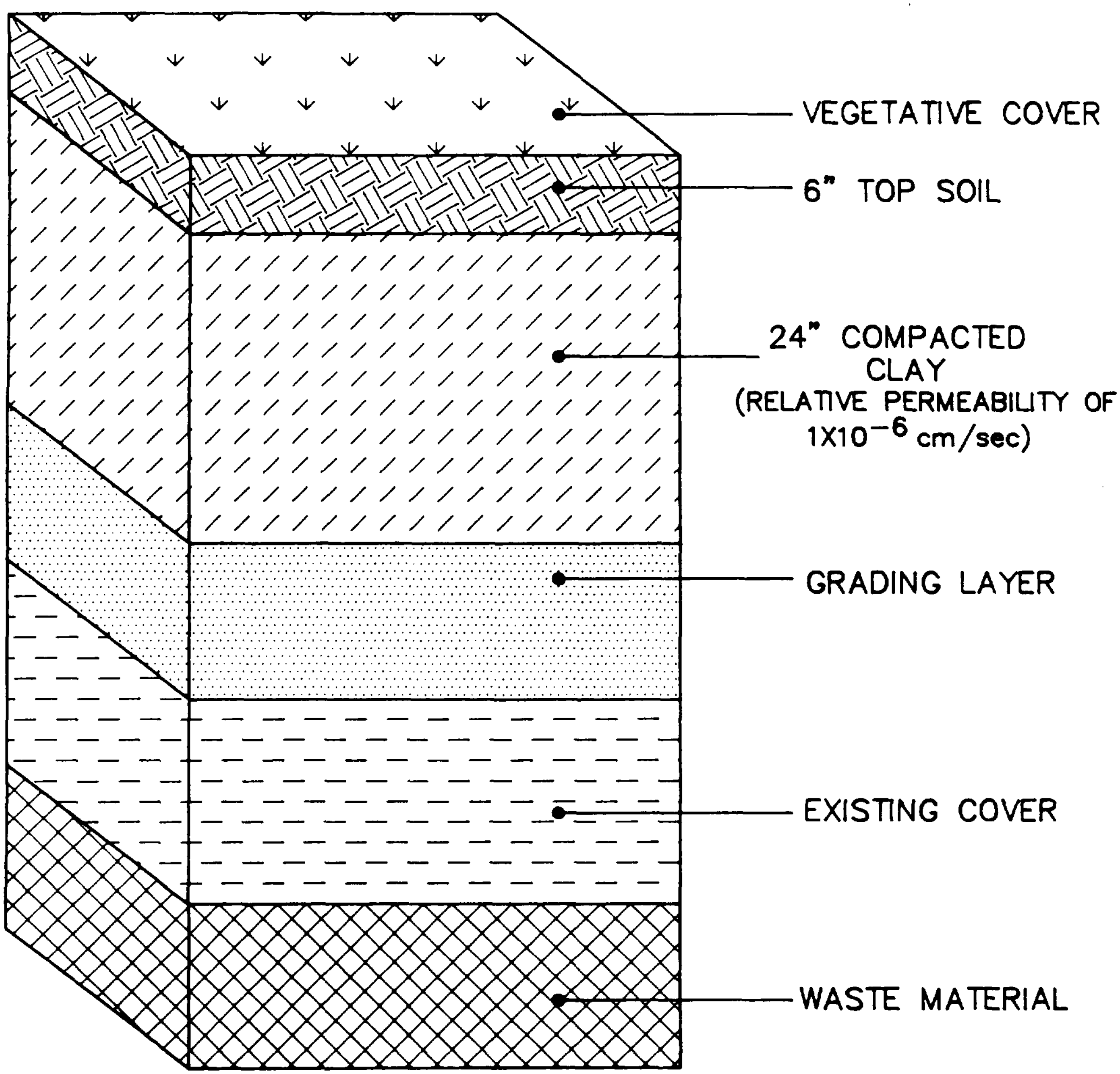
FIGURE 5-6
LANDFILL CAP LOCATION AND SLOPE CONFIGURATION
OLD CITY LANDFILL
COLUMBUS, INDIANA



NOT TO SCALE

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FIGURE 5-7
SANITARY LANDFILL CAP DETAIL
OLD CITY LANDFILL
COLUMBUS, INDIANA

would not actually need to break up the topsoil and take out the plant roots but just cut the existing vegetation as close to the ground surface as possible. A more complete scarification or vegetation removal process, however, would be preferred for construction of an engineered landfill cap. If the vegetation root structure is left in place below the cap a potential would exist for having continued vegetative growth up through the clay layer and for greater differential settlement to occur over the surface of the landfill cap. Both of these possibilities would decrease the effectiveness of the cap in minimizing the amount of infiltration that passes down through the waste material. Thus, the scarification process preferred prior to constructing the sanitary landfill cap would involve cutting into and/or scraping off the upper 6 to 12 inches of the existing soil that covers the landfill. Dust control measures would be implemented to minimize potential exposure risks during this scarification process.

Additional soil could be added to the existing landfill cover material and then regraded to achieve the required slopes. The low permeability clay layer would then be placed in multiple lifts with each lift receiving compaction prior to additional placement of clay. Following placement and inspection of the clay layer, the top soil would then be added, compacted, and seeded.

In addition to the sanitary landfill cap, Alternative 3 would also include the institutional controls provided for Alternative 2. Since these institutional controls have been previously described in Section 5.6.1, they are not described here.

5.8.2 Assessment

The results of assessing Alternative 3 against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The current condition of the OCL does not jeopardize the protection of human health and the environment. This is because the waste material is adequately contained by the existing landfill cover and the RI confirmed that significant releases of contaminants into the surrounding environmental media are not currently occurring. The installation of a sanitary landfill cap would, however, further contain the waste material by functioning as an additional protective barrier over the existing landfill cover. This would further reduce the potential for surface exposure of, and direct contact with, the waste material. It would also reduce the amount of infiltration that passes down through the waste material, thus, reducing the potential for leaching of contaminants which could enter the underlying ground water. As discussed previously in Section 5.6.2, the institutional controls would also be effective in minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases. Thus, Alternative 3 would have a high degree of overall protection to human health and the environment.

Compliance with ARARs

All chemical-specific ARARs are currently being met for the environmental media at the OCL. Unless significant releases of contaminants were to occur some time in the future, all chemical-specific ARARs would continue to be met. Alternative 3 would comply with all action-specific ARARs, including the Indiana Sanitary Landfill Closure regulations. Since the landfill cap would be located within a 100 year flood plain, the IDNR would need to approve the cap design prior to construction. It is assumed that IDNR would approve the cap design and, thus, all location-specific ARARs would also be met.

Long-Term Effectiveness and Permanence

The current risks to human health and the environment associated with the OCL have been determined to be within acceptable health-based and environmental quality-based guidelines. As stated in Section 5.6.2, institutional controls would offer a high degree of long-term effectiveness and permanence in ensuring that the current risks are not exceeded in the future. By providing enhanced source control, via placement of the sanitary landfill cap, the future risks to human health and the environment would be further reduced. Provided that a full vegetative layer is maintained and periodic maintenance is conducted, a sanitary landfill cap would have a high degree of permanence in providing enhanced waste containment. With the combination of institutional controls and a sanitary landfill cap, Alternative 3 would provide a high degree of long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 would not employ treatment to reduce the toxicity, mobility, or volume of the contaminants contained within the landfill waste material.

Short-Term Effectiveness

Installation of the sanitary landfill cap would require scarification and regrading of the existing landfill cover. To limit the dust that may be generated during the scarification activities, the landfill cover will be sprayed intermittently by a fine mist of water as warranted by the existing weather conditions. There would exist a potential for surface exposure of the waste material, especially along the northeastern edge of the landfill where the existing slopes are relatively steep, which could lead to contaminant releases during implementation of Alternative

3. With proper dust and grading control measures, the potential for surface exposure of the waste material could be minimized.

Implementability

As stated in section 5.6.2, the institutional controls proposed for the OCL could all be readily implemented. A sanitary landfill cap, however, would require a rather comprehensive design and construction effort. The main factors influencing the implementation of a sanitary landfill cap involve the local availability of clay and top soil, the ease of obtaining regulatory approval, and the required completion schedule. Contacts with material suppliers have verified the local availability of clay and top soil. Assuming the regulatory agencies would approve the cap design, it is estimated that the sanitary landfill cap could be finished within a 12 to 18 month period. For these reasons, Alternative 3 could be implemented without excessive difficulties.

Costs

The capital costs associated with implementing Alternative 3 are estimated to be \$2,307,000. The annual O&M costs associated with Alternative 3 are estimated to be \$45,000. By applying a 5% discount rate over a 30 year implementation period the total present worth associated with Alternative 3 is estimated to be \$2,999,000. A summary of the cost estimates for Alternative 3 is presented in Table 5-5.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to the USEPA's Proposed Plan.

Table 5-5. Cost Analysis of Alternative 3 for the Old City Landfill Site, Columbus, Indiana

The following cost estimates apply to Alternative 3 which consists of a Sanitary Landfill Cap and Institutional Controls.

CAPITAL REQUIREMENTS		COST
Site Survey (20 acres @ $1,000/acre)		$ 20,000
Soil Borings (20 borings, 10 feet deep in average)		$ 20,000
Existing Cover Scarifying to Remove Vegetation (0.5 ft over 20 acres, or 16,000 cy @ $3.00/cy)		$ 48,000
Placement and Compaction of Grading Layer (57,000 cy @ $8.00/cy)		$ 456,000
Placement and Compaction of Clay (2 ft over 21 acres, or 68,000 cy @ $8.34/cy)		$ 567,000
Placement and Compaction of Top Soil (0.5 ft over 21 acres, or 17,000 cy @ $8.75/cy)		$ 149,000
Seeding of Vegetation Cover (21 acres @ $1,600/acre)		$ 34,000
Drainage Collection Ditch		$ 75,000
Fencing of the Site and Deed Restrictions (as in Alternative 2)		$ 128,000
Mobilization/Demobilization (Lump Sum)		$ 40,000
	Subtotal	$1,537,000

(continued on next page)

Table 5-5. Cost Analysis of Alternative 3 for the Old City Landfill Site, Columbus, Indiana (continued)

The following cost estimates apply to Alternative 3 which consists of a Sanitary Landfill Cap and Institutional Controls.

Engineering (15%)	$ 230,000
Contingency (15%)	$ 231,000
Construction Management (10%)	$ 154,000
Health and Safety (10%)	$ 154,000
TOTAL CAPITAL COST	**$2,307,000**
ANNUAL O & M REQUIREMENTS	
Cap Inspection and Maintenance	$ 20,000
Ground-Water Monitoring	$ 20,000/year
Fence Inspection and Maintenance	$ 5,000/year
ANNUAL O & M COST	**$ 45,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate)	**$2,999,000**

Community Acceptance

The assessment of community acceptance can not be made until after the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan.

5.9 ALTERNATIVE 3A: ROADWAY PLACEMENT WITH SANITARY LANDFILL CAP

Alternative 3A would combine placement of the proposed roadway with a sanitary landfill cap. Institutional controls would also be provided under this alternative.

5.9.1 Detailed Description

Placement of the roadway would be accomplished as previously described in Section 5.5.1. Except for coordination issues with the sanitary landfill cap that are discussed below, all aspects of the roadway would remain the same. Since a detailed description of the proposed roadway was given previously in this report, it will not be repeated here.

The sanitary landfill cover provided under this alternative would be as described in Section 5.8.1 for Alternative 3. The institutional controls provided under this alternative would be as described in Section 5.7.1 for Alternative 2A. Except for coordination issues with the proposed roadway that are discussed below, all aspects of the sanitary landfill cap and institutional controls would remain the same. The reader is referred to Sections 5.7.1 and 5.8.1 for detailed descriptions of the institutional controls and the sanitary landfill cap, respectively.

The critical aspects of Alternative 3A would be coordinating the placement of the roadway with placement of the sanitary landfill cap and ensuring that the effectiveness of the cap is not adversely impacted by the placement and long-term existence of the proposed roadway. To ensure that these aspects are properly addressed and accounted for, the design and construction sequence for the sanitary landfill cap and the proposed roadway would have to be altered.

The most important factor in modifying the design and position of the sanitary landfill cap would be to minimize the effect of differential subsidence once the cap is in place. As stated in Section 5.5.1, there is a potential for maximum subsidence in excess of four feet to occur due to placement and compaction of the roadway fill material. A subsidence differential of four feet over the width of the roadway fill embankments would likely cause cracking and a loss of integrity of the clay layer contained within the sanitary landfill cap. Thus, to ensure that the cap would function as a continuous, low permeability layer over the landfill, it should not be subjected to the full subsidence expected from placement of the roadway fill material.

The optimum construction sequence would have placement of the sanitary landfill cover occurring after the full magnitude of subsidence had occurred. However, since subsidence may continue to occur for many years, this would not be a viable construction option. A more viable option would be to allow the majority of subsidence (i.e., primary settelment) to occur, which most likely would be realized during the first six to twelve months following placement of the roadway fill, prior to placing the cap over the section of the landfill covered by the roadway. It is thus anticipated that approximately 75%, in cross sectional area, of the roadway fill material would be placed and compacted as the initial construction phase for Alternative 3A. This roadway fill would sit undisturbed for a minimum of six months at which time construction of the cap could begin at the southern end of the landfill. Following this six month period, in which a substantial amount of the ultimate subsidence would have taken place, the cap would be placed up and across the roadway fill embankments.

The slopes of the cap would conform with the requirements set forth in 329 IAC 2-14-19. Following installation and inspection of the cap, the remaining roadway fill material would be placed and compacted up to its required height. Figure 5-8 illustrates a cross section of the Indiana Sanitary Landfill Cap through the proposed roadway fill embankments. Placement and compaction of this additional material, as well as construction of the roadway surface and its appurtenances, would be done so as not to create any point loads which could damage the cap. Due to the wide uniform load distribution that would result from the substantial amount of roadway fill material above the cap, it is assumed that vehicle traffic would not adversely affect the condition of the landfill cover. This assumption would be verified during the final geotechnical design of the roadway and sanitary landfill cap. The final geotechnical design would identify if the cap would need to be reinforced under the line of the roadway.

The technical requirements for combining the proposed roadway with a sanitary landfill cap, as well as the necessity and value of the anticipated construction sequence, could not be concluded until after analyzing the results of the preload testing program. After the analysis of the preload testing results, a better determination could be made, based on the anticipated rate and magnitude of the subsidence, as to the technical requirements and most viable construction sequence for installing the cap in combination with the proposed roadway. This information will be summarized in a technical supplement to the feasibility study, which will be submitted to the agencies prior to selection of a remedy.

An additional concern in coordinating the sanitary landfill cap with placement of the proposed roadway would be surface runoff control. As stated in Section 5.5.1, if the roadway is constructed over the existing landfill cover without the addition of an engineered cap, the current drainage patterns would be maintained. This would be accomplished by placing a culvert within the roadway fill material at the resultant low point to provide an opening for runoff that currently flows through the swale formed by the low point. In order to minimize the potential for erosion of the landfill cap, drainage collection channels, constructed out of crushed aggregate,

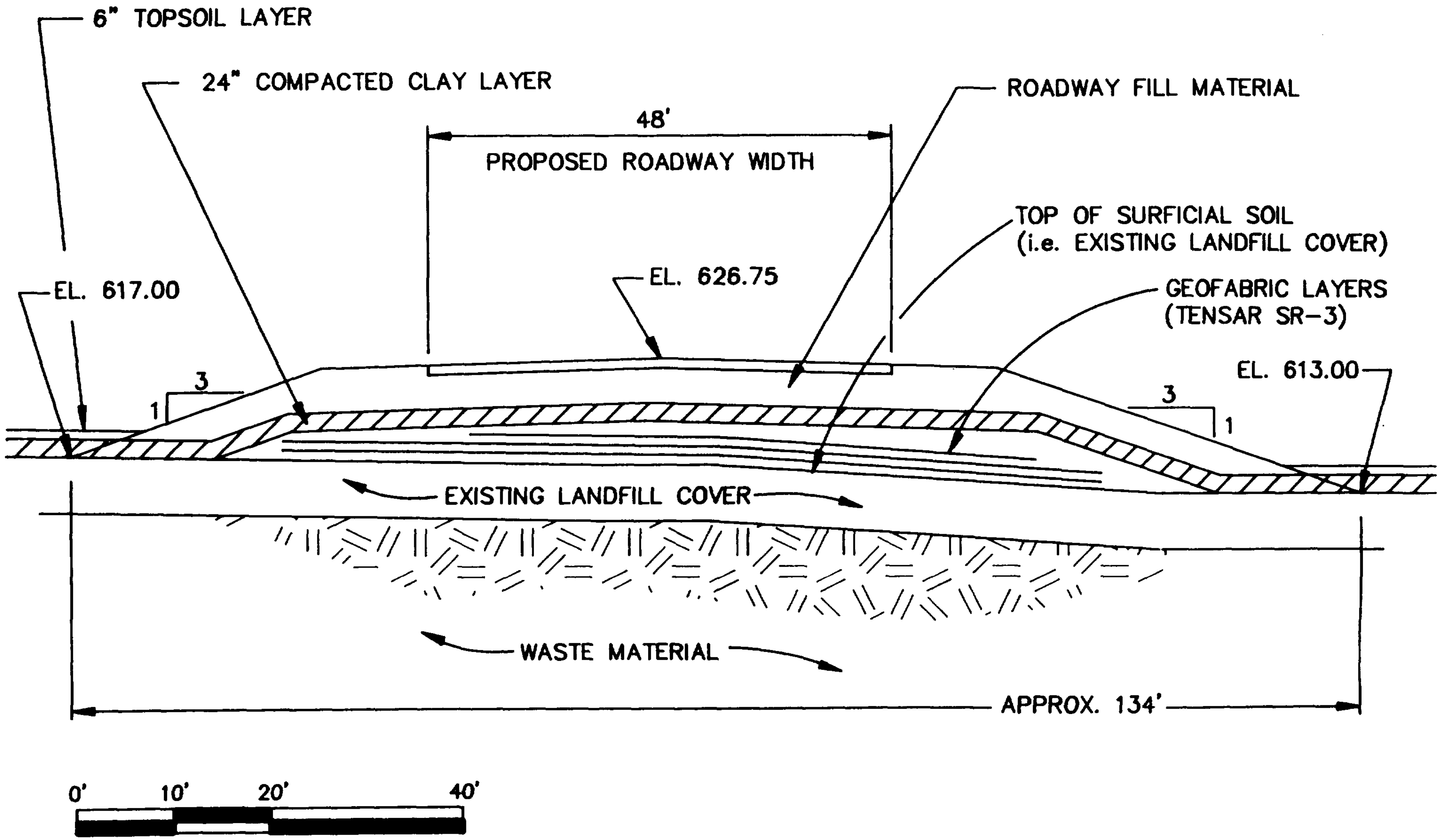

FIGURE 5-8

SANITARY LANDFILL CAP CROSS SECTION
THROUGH PROPOSED ROADWAY

OLD CITY LANDFILL
COLUMBUS, INDIANA

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would be placed along both sides of the roadway fill embankment. These drainage collection channels would be hydraulically connected to the collection ditch that would be placed around the periphery of the landfill. To facilitate this hydraulic connection, additional culverts would most likely be required underneath the roadway.

5.9.2 Assessment

The results of assessing alternative 3A against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The assessment of a sanitary landfill cap and institutional controls that was presented for Alternative 3 in Section 5.8.2 also applies to the assessment of Alternative 3A. This assessment concluded that a sanitary landfill cap in combination with institutional controls would offer a high degree of overall protection to human health and the environment. The inclusion of the roadway as part of Alternative 3A would not significantly diminish the degree of overall protection provided. The long-term effectiveness of the sanitary landfill cap would not be adversely impacted by the roadway because the majority of subsidence would occur prior to placement of the cap, thus, limiting the potential for cracking of the clay layer. Due to the surface containment of the waste material provided by the roadway fill material, sanitary landfill cap, and the existing landfill cover, contact with the waste materials by any persons or vehicles straying from the roadway would be prevented.

The additional institutional controls provided in combination with the proposed roadway (i.e., leachate seep inspections, the development of a ground-water recovery system contingency plan, etc.) would ensure that proper remedial response actions could be taken to abate any contaminant releases that may occur. For these reasons, Alternative 3A would provide a high degree of overall protection to human health and the environment.

Compliance with ARARs

All chemical-specific ARARs are currently being met for the environmental media at the OCL. If chemical specific ARARs were to be exceeded some time in the future, appropriate remedial action would be taken to ensure off-site migration of contaminants would not occur and that appropriate cleanup measures would be implemented. The roadway and bridge, sanitary landfill cap, and institutional controls would comply with all pertinent action-specific and location-specific ARARs.

Long-Term Effectiveness and Permanence

As stated above, placement of the roadway would not adversely impact the long-term effectiveness and permanence of the sanitary landfill cap. In addition, institutional controls would offer long-term effectiveness and permanence in addressing and controlling the potential environmental impacts associated with the proposed roadway. Thus, Alternative 3A would offer a high degree of long-term effectiveness and permanence.

Reduction of Toxicity, Mobility and Volume through Treatment

Alternative 3A would not employ treatment and, therefore, would not reduce the toxicity, mobility, or volume of the contaminants contained within the landfill waste material.

Short-Term Effectiveness

For the reasons stated in Sections 5.7.2 and 5.8.2, implementation of a sanitary landfill cap and the proposed roadway and bridge would provide a moderately low degree of short-term effectiveness in meeting the remedial response objectives.

Implementability

The assessment of implementability for a sanitary landfill cap and institutional controls presented for Alternative 3 in Section 5.8.2 also applies to the assessment of Alternative 3A. For Alternative 3A, however, the sanitary landfill cap would be more difficult to implement due to its combination with the roadway placement. The combination of the roadway and sanitary landfill cap is technically very feasible but the schedule of implementation for the cap would need to be extended. This is due to the fact that the cap construction could not be completed until after the roadway fill material had been placed and the majority of subsidence had occurred.

Costs

The capital costs associated with implementing the sanitary landfill cap and institutional controls for Alternative 3A are estimated to be $2,439,000. This cost estimate is higher than that for Alternative 3 because it reflects the potential for additional ground water monitoring wells and the developement of a ground-water recovery system contingency plan. The annual O&M costs associated with Alternative 3A are estimated to be $75,000. By applying a 5% discount rate over a 30 year implementation period the total present worth associated with Alternative 3A is estimated to be $3,592,000. A summary of the cost estimates for Alternative 3A is presented in Table 5-6.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after the public comment period in which the public will have an opportunity to resond to the USEPA's Proposed Plan. It is anticipated, however, that the community would be in strong support of the roadway and bridge.

5.10 ALTERNATIVE 4 - RCRA SUBTITLE C CAP

Alternative 4 would consist of placing a RCRA Subtitle C Cap over the existing landfill surface. The institutional controls identified for Alternative 2 in Section 5.6.1 would also be provided as part of Alternative 4.

5.10.1 Detailed Description

Alternative 4 would be essentially similar to Alternative 3, except that a RCRA Subtitle C Cap would be used instead of a Indiana Sanitary Landfill Cap. Apart from the differences in the design of the cap, which are discussed below, all aspects of Alternative 4 would be identical to those described in Section 5.8.1 for Alternative 3. The reader is referred to Section 5.8.1 for a discussion on the implementation of an engineered landfill cap and the institutional controls provided as part of Alternative 4.

Table 5-6. Cost Analysis of Alternative 3A for the Old City Landfill Site, Columbus, Indiana

The following cost estimates apply to Alternative 3A which consists of a Sanitary Landfill Cap, Roadway Placement, and Institutional Controls. Costs for the roadway are not included.

CAPITAL REQUIREMENTS	COST
Site Survey (20 acres @ $1,000/acre)	$ 20,000
Soil Borings (20 borings, 10 feet deep in average)	$ 20,000
Existing Cover Scarifying to Remove Vegetation (0.5 ft over 20 acres, or 16,000 cy @ $3.00/cy)	$ 48,000
Placement and Compaction of Grading Layer (57,000 cy @ $8.00/cy)	$ 456,000
Placement and Compaction of Clay (2 ft over 21 acres, or 68,000 cy @ $8.34/cy)	$ 567,000
Placement and Compaction of Top Soil (0.5 ft over 21 acres, or 17,000 cy @ $8.75/cy)	$ 149,000
Seeding of Vegetation Cover (21 acres @ $1,600/acre)	$ 34,000
Drainage Collection Ditch	$ 75,000
Fencing of the Site and Deed Restrictions (as in Alternative 2)	$ 128,000
Development of Ground-Water Recovery System Implementation Plan (includes Analytical Modelling and Preliminary Design)	$ 40,000
Additional Monitoring Wells (8 wells)	$ 40,000

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Table 5-6. Cost Analysis of Alternative 3A for the Old City Landfill Site, Columbus, Indiana (continued)

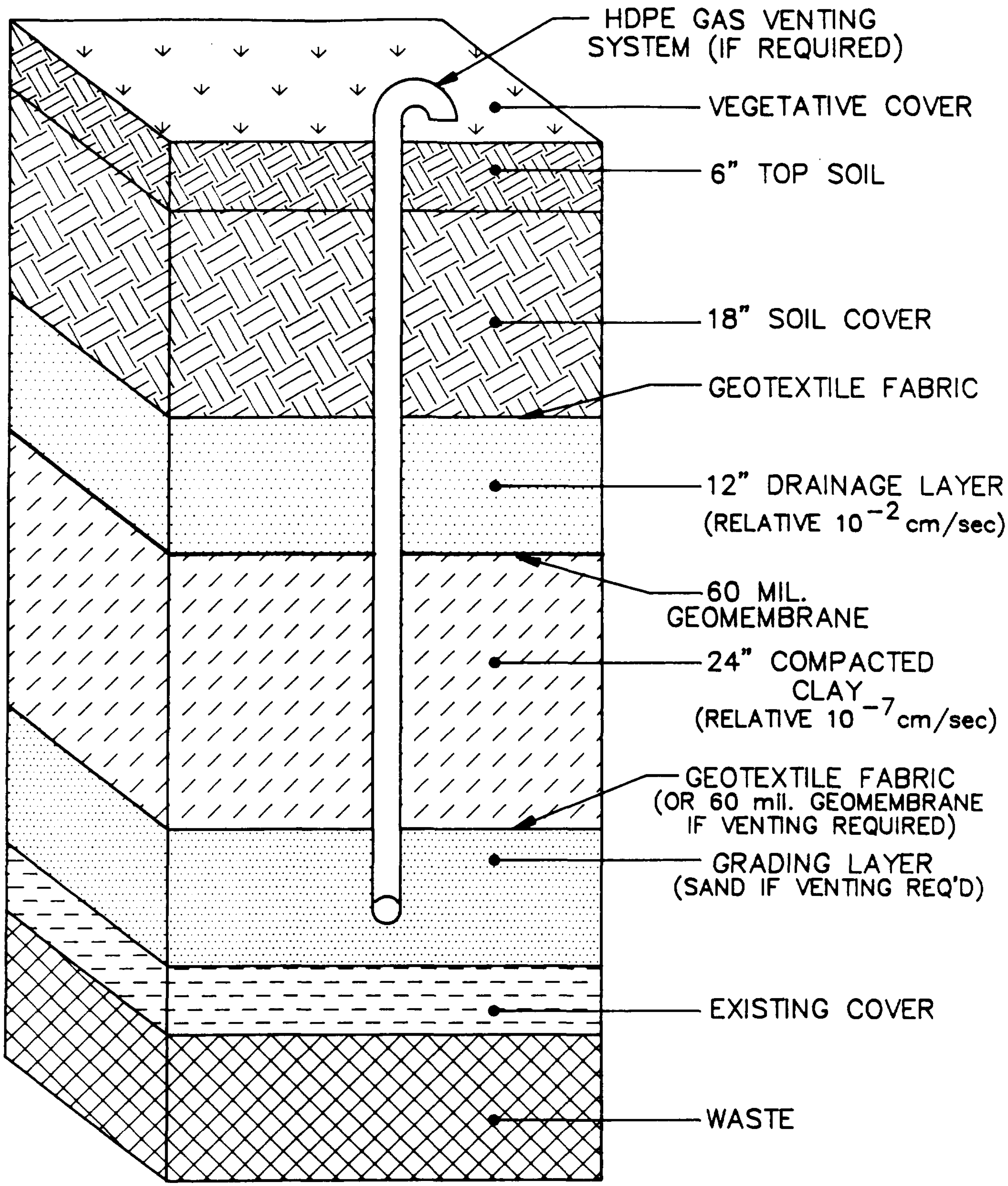
The following cost estimates apply to Alternative 3A which consists of a Sanitary Landfill Cap, Roadway Placement, and Institutional Controls. Costs for the roadway are not included.

Mobilization/Demobilization (Lump Sum)	$ 50,000
Subtotal	$1,627,000
Engineering (15%)	$ 244,000
Contingency (15%)	$ 244,000
Construction Management (10%)	$ 162,000
Health and Safety (10%)	$ 162,000
TOTAL CAPITAL COST	**$2,439,000**
ANNUAL O & M REQUIREMENTS	
Cap Inspection and Maintenance	$ 20,000
Ground-Water Monitoring	$ 50,000/year
Fence Inspection and Maintenance	$ 5,000/year
ANNUAL O & M COST	**$ 75,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate; not including the cost of roadway)	**$3,592,000**

A RCRA Subtitle C Cap would provide additional material layers to that of the sanitary landfill cap to minimize the amount of infiltration that could pass through the cap. In accordance with 40 CFR 264.310 and USEPA Technical Guidance (USEPA 1989b), the RCRA Subtitle C Cap would include a two-component low permeability layer consisting of a two foot clay layer with an in-place saturated hydraulic conductivity of no greater than 1×10^{-7} cm/sec, overlaid by a 60 mil flexible membrane liner. The low permeability layer would be overlaid by a soil drainage layer, 12 inches in thickness, with a minimum hydraulic conductivity of 1×10^{-2} cm/sec. The drainage layer would minimize water infiltration into, and protect, the underlying low permeability layer. The soil drainage layer would be overlaid by a two foot layer of top soil that would include a full vegetative cover. As with the sanitary landfill cap, the top of the RCRA Subtitle C Cap would be sloped at 4% while the sides would be sloped at 25%. The location and slope configuration of the cap would be as shown on Figure 5-6. A typical cross section of a RCRA Subtitle C Cap is shown on Figure 5-9.

As with the sanitary landfill cap, the RCRA Subtitle C Cap would be placed over the existing landfill cover which would be scarified and then regraded to achieve the necessary slopes. Since the organic matter in the waste material has undoubtedly been subjected to extensive biological degradation, it is assumed that landfill gases are no longer being generated and, thus, a soil venting layer underlying the cap would not be required.

To handle the infiltration collected by the soil drainage layer, a collection pipe, would be placed within the toe of the landfill cap along its entire length. This collection pipe would discharge into the drainage collection ditch that would be placed around the periphery of the landfill.



NOT TO SCALE

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Environmental Services

FIGURE 5-9
RCRA SUBTITLE C
MULTI-MEDIA CAP DETAIL
OLD CITY LANDFILL
COLUMBUS, INDIANA

5.10.2 Assessment

The results of assessing Alternative 4 against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The assessment presented in Section 5.8.2 concluded that Alternative 3 would provide a high degree of overall protection to human health and the environment. Since the RCRA Subtitle Cap would offer equal or better protection in reducing infiltration and limiting the potential for surface exposure of the waste material than would the sanitary landfill cap or the existing cover, Alternative 4 would also provide a high degree of overall protection to human health and the environment.

Compliance with ARARs

All chemical-specific ARARs are currently being met for the environmental media at the OCL. Unless significant releases of contaminants were to occur, although unlikely, some time in the future, all chemical-specific ARARs would continue to be met. The implementation of a RCRA Subtitle C Cap and institutional controls would comply with all pertinent action-specific ARARs. Assuming that IDNR would approve the cap design, all location-specific ARARs would also be met.

Long-Term Effectiveness and Permanence

The assessment presented in Section 5.8.2 concluded that Alternative 3 would provide a high degree of long-term effectiveness and permanence. Since a RCRA Subtitle C Cap would provide equal or better long-term effectiveness and permanence than would a sanitary landfill cap or the existing cover, Alternative 4 would also provide a high degree of long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 would not employ treatment to reduce the toxicity, mobility, or volume of the contaminants contained within the landfill waste material.

Short-Term Effectiveness

For the same reasons stated in Section 5.8.2, Alternative 4 would have a moderately low degree of short-term effectiveness.

Implementability

Section 5.8.2 concluded that Alternative 3 could be implemented without excessive difficulties; however, it was estimated that implementation of a sanitary landfill cap would require a 12 to 18 month period. This assessment also applies to Alternative 4 except that implementation of a RCRA Subtitle C Cap would likely require a 15 to 21 month period.

Costs

The capital costs associated with implementing Alternative 4 are estimated to be $5,057,000. The annual O&M costs associated with Alternative 4 are estimated to be $45,000. By applying a 5% discount rate over a 30 years implementation period the total present worth associated with Alternative 4 is estimated to be $5,749,000. A summary of the costs estimates for Alternative 4 is presented in Table 5-7.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan.

5.11 ALTERNATIVE 4A: ROADWAY PLACEMENT WITH RCRA SUBTITLE C CAP

Alternative 4A would combine placement of the proposed roadway with a RCRA Subtitle C Cap. Institutional controls would also be provided under this alternative.

5.11.1 Detailed Description

The combination of a RCRA Subtitle C Cap with the proposed roadway would be nearly identical to the combination of a sanitary landfill cap with the proposed roadway described in Section 5.9.1, for Alternative 3A. The only difference would be the additional layers required in a RCRA Subtitle C Cap over that required in an Indiana Sanitary Landfill Cap. The reader is referred to sections 5.9.1 and 5.10.1 for discussions on coordinating the roadway with an

Table 5-7. Cost Analysis of Alternative 4 for the Old City Landfill Site, Columbus, Indiana

The following cost estimates apply to Alternative 4 which consists of a RCRA Multi-Media Cap and Institutional Controls.

CAPITAL REQUIREMENTS	COST
Site Survey (20 acres @ $1,000/acre)	$ 20,000
Soil Borings (20 borings, 10 feet deep in average)	$ 20,000
Existing Cover Scarifying to Remove Vegetation (0.5 ft over 20 acres, or 16,000 cy @ $2.10/cy)	$ 34,000
Placement and Compaction of Grading Layer (57,000 cy @ $8.00/cy)	$ 456,000
Placement and Compaction of Clay (2 ft over 21 acres, or 68,000 cy @ $8.34/cy)	$ 567,000
Placement of 60 mil HDPE geomembrane (914,800 sf @ $1.20/sf)	$1,098,000
Placement and Compaction of Drainage Layer (1 ft over 21 acres, or 34,000 cy @ $6.34/cy)	$ 216,000
Placement of Geotextile Fabric (95,850 sf @ $0.50/sf)	$ 48,000
Placement and Compaction of Soil cover (1.5 ft over 21 acres, or 51,000 cy @ $8.00/cy)	$ 408,000
Placement and Compaction of Top Soil (0.5 ft over 21 acres, or 17,000 cy @ $8.75/cy)	$ 149,000

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Table 5-7. Cost Analysis of Alternative 4 for the Old City Landfill Site, Columbus, Indiana (continued)

The following cost estimates apply to Alternative 4 which consists of a RCRA Multi-Media Cap and Institutional Controls.

Seeding of Vegetation Cover (21 acres @ $1,600/acre)	$ 34,000
Drainage Pipe System (7,000 lf @ $11.12/lf)	$ 78,000
Drainage Collection Ditch	$ 75,000
Fencing of the Site and Deed Restrictions (as in Alternative 2)	$ 128,000
Mobilization/Demobilization (Lump Sum)	$ 40,000
Subtotal	$3,371,000
Engineering (15%)	$ 506,000
Contingency (15%)	$ 506,000
Construction Management (10%)	$ 337,000
Health and Safety (10%)	$ 337,000
TOTAL CAPITAL COST	**$5,057,000**
ANNUAL O & M REQUIREMENTS	
Cap Inspection and Maintenance	$ 20,000/year
Ground-Water Monitoring	$ 20,000/year

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Table 5-7. Cost Analysis of Alternative 4 for the Old City Landfill Site, Columbus, Indiana (continued)

The following cost estimates apply to Alternative 4 which consists of a RCRA Multi-Media Cap and Institutional Controls.

Fence Inspection and Maintenance	$ 5,000/year
ANNUAL O & M COST	**$ 45,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate)	**$5,749,000**

engineered landfill cap and the requirements for a RCRA Subtitle C Cap, respectively. All aspects of Section 5.9.1 apply to coordinating a RCRA Subtitle C Cap with placement of the roadway except for differences in the cap cross section. To illustrate these differences, Figure 5-10 presents a cross section of the RCRA Subtitle C Cap through the proposed roadway fill embankments.

The institutional controls provided as part of Alternative 4A are identical to those described in Section 5.7.1 for Alternative 2A. The reader is referred to Section 5.7.1 for a description of these institutional controls.

5.11.2 Assessment

The results of assessing alternative 4A against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

The assessment presented in Section 5.9.2 concluded that Alternative 3A would provide a high degree of overall protection to human health and the environment. Since the RCRA Subtitle C Cap would offer equal or better protection in reducing infiltration and limiting the potential for surface exposure of the waste material than would a sanitary landfill cap or the existing landfill cover, Alternative 4A would also provide a high degree of overall protection to human health and the environment.

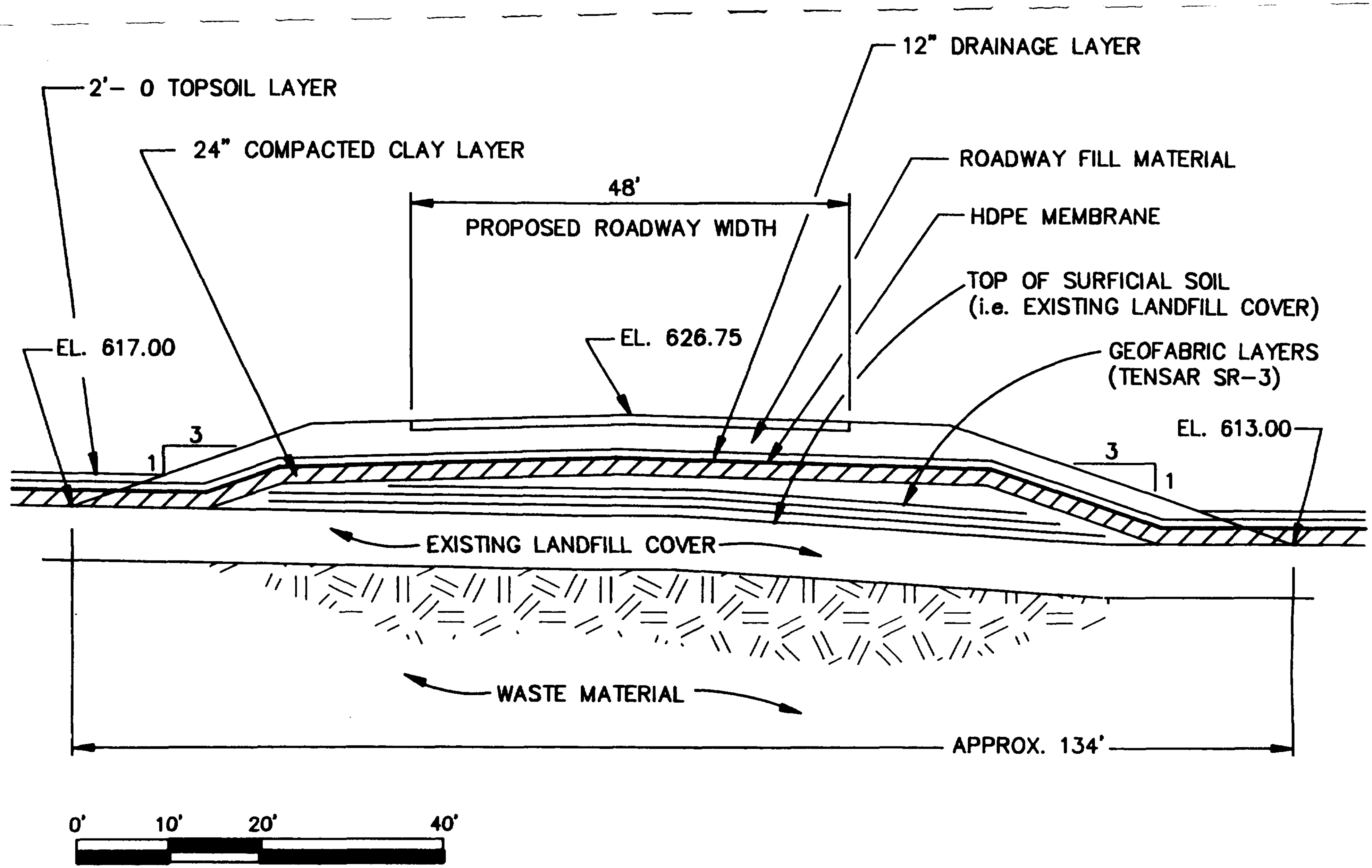

FIGURE 5-10
RCRA SUBTITLE C CAP CROSS SECTION THROUGH PROPOSED ROADWAY
OLD CITY LANDFILL
COLUMBUS, INDIANA

GERAGHTY & MILLER, INC.
Environmental Services

Compliance with ARARs

As stated previously, all chemical-specific ARARs are currently being met for the environmental media at the OCL and unless significant releases of contaminants were to occur, although unlikely, some time in the future, all chemical-specific ARARs would continue to be met. The roadway and bridge, RCRA Subtitle C Cap, and institutional controls would comply with all pertinent location and action-specific ARARs.

Long-Term Effectiveness and Permanence

The assessment presented in Section 5.9.2 concluded that, even in combination with the proposed roadway, the sanitary landfill cap and institutional controls that comprise Alternative 3A would provide a high degree of long-term effectiveness and permanence. Since a RCRA Subtitle C Cap would provide equal or better long-term effectiveness and permanence than would a sanitary landfill cap or the existing landfill cover, Alternative 4A would also provide a high degree of long-term effectiveness and permanence.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4A would not employ treatment to reduce the toxicity, mobility, or volume of the contaminants contained within the landfill waste material.

Short-Term Effectiveness

For the same reasons stated in Sections 5.7.2 and 5.8.2, Alternative 4A would have a moderately low degree of short-term effectiveness.

Implementability

The assessment of implementability for a RCRA Subtitle C Cap and institutional controls presented for Alternative 4 in section 5.10.2 also applies to the assessment of Alternative 4A. The combination of these remedial actions with placement of the roadway is technically feasible; however, the schedule of implementation period for the RCRA Subtitle C Cap in combination with the proposed roadway is anticipated to be 18 to 24 months.

Cost

The capital costs associated with implementing the RCRA Subtitle C Cap and institutional controls for Alternative 4A are estimated to be $5,191,000. This cost estimate is higher than that for Alternative 4 because it reflects the potential for additional ground water monitoring wells and the development of a ground-water recovery system contingency plan. The annual O&M costs associated with Alternative 4A are estimated to be $75,000. By applying a 5% discount rate over a 30 year period the total present worth associated with Alternative 4A is estimated to be $6,344,132. A summary of the cost estimates for Alternative 4A is presented in Table 5-8.

State Acceptance

The assessment of state acceptance can not be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's

Table 5-8. Cost Analysis of Alternative 4A for the Old City Landfill Site, Columbus, Indiana.

The following cost estimates apply to Alternative 4A which consists of a RCRA Multi-Media Cap, Roadway Placement, and Institutional Controls. Costs for the roadway are not included.

CAPITAL REQUIREMENTS	COST
Site Survey (20 acres @ $1,000/acre)	$ 20,000
Soil Borings (20 borings, 10 feet deep in average)	$ 20,000
Existing Cover Scarifying to Remove Vegetation (0.5 ft over 20 acres, or 16,000 cy @ $2.10/cy)	$ 34,000
Placement and Compaction of Grading Layer (57,000 cy @ $8.00/cy)	$ 456,000
Placement and Compaction of Clay (2 ft over 21 acres, or 68,000 cy @ $8.34/cy)	$ 567,000
Placement of 60 mil HDPE geomembrane (914,800 sf @ $1.20/sf)	$1,098,000
Placement and Compaction of Drainage Layer (1 ft over 21 acres, or 34,000 cy @ $6.34/cy)	$ 216,000
Placement of Geotextile Fabric (95,850 sf @ $0.50/sf)	$ 48,000
Placement and Compaction of Soil cover (1.5 ft over 21 acres, or 51,000 cy @ $8.00/cy)	$ 408,000
Placement and Compaction of Top Soil (0.5 ft over 21 acres, or 17,000 cy @ $8.75/cy)	$ 149,000

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Table 5-8. Cost Analysis of Alternative 4A for the Old City Landfill Site, Columbus, Indiana.
(continued)

The following cost estimates apply to Alternative 4A which consists of a RCRA Multi-Media Cap, Roadway Placement, and Institutional Controls. Costs for the roadway are not included.

Seeding of Vegetation Cover (21 acres @ $1,600/acre)		$ 34,000
Drainage Pipe System (7,000 lf @ $11.12/lf)		$ 78,000
Drainage Collection Ditch		$ 75,000
Fencing of the Site and Deed Restrictions (as in Alternative 2)		$ 128,000
Development of Ground-Water Recovery System Implementation Plan (includes, Analytical Modelling, and Preliminary Design)		$ 40,000
Additional Monitoring Wells (8 wells)		$ 40,000
Mobilization/Demobilization (Lump Sum)		$ 50,000
	Subtotal	$3,461,000
Engineering (15%)		$ 519,000
Contingency (15%)		$ 519,000
Construction Management (10%)		$ 346,000

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Table 5-8. Cost Analysis of Alternative 4A for the Old City Landfill, Columbus, Indiana (continued)

The following cost estimates apply to Alternative 4A which consists of a RCRA Multi-Media Cap, Roadway Placement, and Institutional Controls. Costs for roadway are not included.

Health and Safety (10%)	$ 346,000
TOTAL CAPITAL COST	**$5,191,000**
ANNUAL O & M REQUIREMENTS	
Cap Inspection and Maintenance	$ 20,000/year
Ground-Water Monitoring	$ 50,000/year
Fence Inspection and Maintenance	$ 5,000/year
ANNUAL O & M COST	**$ 75,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate; not including the cost of roadway)	**$6,344,000**

Proposed Plan. It is anticipated, however, that the community would be in strong support of the roadway and bridge.

5.12 ALTERNATIVE 5: ON-SITE STABILIZATION/SOLIDIFICATION

Alternative 5 would utilize on-site solidification/stabilization in order to treat the waste material within the OCL.

5.12.1 Detailed Description

Alternative 5 would consist of an on-site, above ground solidification/stabilization waste treatment process with on-site disposal of the treated waste back into the OCL. A soil cover would be placed over the treated waste and periodic ground-water monitoring would be provided as the means for verifying the effectiveness of the remediation effort. Due to the heterogeneity of the large volume of waste material within the OCL, and the fact that only relatively low levels of hazardous constituents, primarily inorganics, were detected in the waste, on-site solidification/ stabilization was established as the only treatment option that would be potentially effective for the reduction of mobility, toxicity or volume of the OCL waste material. Institutional controls described in Section 5.6.1 Alternative 2 would also apply to Alternative 5.

Evaluation of the chemical constituents within the waste matrix is necessary prior to selecting appropriate solidifying/stabilizing reagents. Therefore, bench-scale studies would be conducted to determine the optimal mixture of reagents to treat the inorganic constituents. These reagents typically include portland cement, lime, pozzalonic materials, kiln dust and various silicate mixtures. Excavated material from the landfill would be analyzed visually at the site and representative samples shipped to a lab for treatment analysis. Wastes can be solidified, which reduces the surface area across which leaching could occur and improves the structural integrity of the waste, by adding a mixture of adsorbents or binding agents such as kiln dust, fly ash or lime. Stabilization of the wastes, which decreases the solubility, and thus the mobility of the waste constituents, can be achieved by adding proper amounts of solidifying agents with the combination of portland cement, pozzalonic material and silica mixtures. These combinations can render the waste constituents immobile and provide a high degree of protection. Stabilization could also potentially decrease the toxicity of the contaminants by altering their chemical form. The capability of solidifying the waste to reduce leachate or stabilizing it to eliminate leachate potential, would be made in the laboratory during the treatability tests.

Once the combinations of agents are decided in the laboratory, large scale purchase and hauling of the reagents and admixtures (i.e. adsorbents) to the site would be necessary. A large, secure working area located adjacent to the landfill would have to be constructed for heavy machinery, mixing devices, mixing hoppers and conveyance systems. Mixing of the reagents with the wastes could also be achieved inside of lagoons that could be constructed adjacent to the landfill. Additionally, substantial area would be necessary to allow for the staging and sorting of landfill debris and materials as excavation proceeds. The large area required to set-up operations requires careful planning and implementation of a phased approach to excavating, staging, sorting, and treating the hazardous constituents. Some debris may serve as admixture if broken and crushed on site. Other debris would have to be stored and used as backfill when possible. Bulky material that could not either be crushed into admixture or backfilled would have to be hauled to a sanitary landfill.

A sequencing process would be established so that sections of the waste material could be excavated, segregated, treated and placed of back into the excavated pit. The treated waste would be compacted and then covered with a soil cover to achieve proper grade. The mixtures used to treat the hazardous constituents would increase the volume of the waste material;

however, the volume increase could not be estimated until after completion of the laboratory testing.

After the treatment is complete, a graded backfill with vegetative cover would be placed upon the fill material, to assist in drainage and water transpiration. Periodic ground-water monitoring using a limited number of existing monitoring wells would be accomplished as the means for verifying the effectiveness of the remediation effort.

5.12.2 Assessment

The results of assessing Alternative 5 against the nine evaluation criteria are presented below.

Overall Protection of Human Health and the Environment

Although it is expected that the risks to human health and the environment associated with the current and continued existence of OCL would remain negligible, the use of stabilization/solidification may provide a safety factor that would either eliminate or substantially reduce any long-term releases to the environment from the OCL. The practicality of using a treatment technology at OCL offers marginal or questionable benefits since, to properly treat the heterogenous waste material, complete excavation would be required. This excavation could lead to contaminant releases into the environmental media surrounding the OCL, thus, potentially increasing the risks to human health and the environment.

Stabilization/solidification techniques are often applied as the means for rendering a waste non-hazardous, based on its characteristics. The determination of hazardous characteristics is made based on the results of toxicity characteristic leaching procedure (TCLP) tests. In some cases, the wastes can only be solidified to remove any free liquids and to meet the necessary unconfined compressive strength standards and the leachate, although substantially reduced, can exceed the TCLP limits. The goal of stabilizing/solidifying wastes at the OCL would be to pass the limits of the TCLP. In order to comply with RCRA LDRs, discussed in Section 4.2.4.1, the solidification/stabilization process utilized for the OCL waste material would have to render the waste non-hazardous (i.e., pass the TCLP test). If the treatment process could not achieve this, then ARARs applying to RCRA LDRs would not be complied with. In this case, either an ARAR waiver (i.e. LDR treatability variance) would need to be granted or another treatment option would have to be considered.

The determination of the overall protection of human health and the environment provided by Alternative 5 has to be made by weighing the long-term benefits of eliminating or significantly reducing the potential for contaminant releases against the environmental impacts caused by excavating approximately 500,000 cubic yards of waste material. Although the solidification/stabilization process would eliminate or reduce the potential for contaminant releases once the entire volume of waste was treated, the RI concluded that significant contaminant releases are not currently occurring. Since the OCL has been in its present state for in excess of 20 years, it is unlikely that significant releases of contaminants would occur in the future. Excavating the waste material, however, would strongly increase the short-term potential for contaminant releases during implementation of Alternative 5. Since it would not be possible to entirely prevent contaminant releases from occurring during its implementation, Alternative 5 would only provide a moderate degree of overall protection of human health and the environment.

Compliance with ARARs

All chemical-specific ARARs are currently being met. By eliminating or significantly reducing the potential for contaminant releases to occur once the waste would be completely treated, the solidification/stabilization process would ensure that chemical-specific ARARs would not be exceeded in the future. Provided that the solidification/stabilization process would be effective to the point where the treated waste could pass the TCLP test, then all location and action-specific ARARs would be met.

Long-Term Effectiveness and Permanence

This criterion is demonstrated through the application of the TCLP to discrete amounts of stabilized/solidified samples that would, for quality control purposes, be sent to a laboratory for a TCLP analysis during the timeframe of the remediation. Provided that treatment by stabilization/solidification meets the TCLP concentration limits, long term effectiveness and permanence would be improved. Should the technology marginally fail the TCLP, the reduction in the potential for leaching of contaminants still would be significant and, thus, even though an ARAR would be exceeded, Alternative 5 would still provide a high degree of long-term effectiveness and permanence.

Long-term effectiveness and permanence would be continually measured and demonstrated through a ground-water monitoring program. Periodic inspections and maintenance of the soil cover would provide continued assurance that the amount of infiltration would be minimized thus further minimizing the slightest probability of producing a leachate from the stabilized/solidified wastes.

Reduction of Toxicity, Mobility and Volume through Treatment

Laboratory bench tests and utilization of the TCLP would provide quantifiable results that would record the reduction of toxicity and mobility of the constituents found within the OCL. Although the percent reduction in mobility is expected to be high, the incremental reduction in mass loading to the underlying ground water would be insignificant due to the low levels of leachate generated under current conditions. The volume of waste, itself, would not be altered.

Short-Term Effectiveness

Implementation of a stabilization/solidification process would require extreme disruption of the buried wastes in order to excavate and sort the waste, pulverize and shred it and mix the treatable portion with the proper reagents. During this excavation and treatment process, some amounts of waste material would escape to the atmosphere, primarily as fugitive dust generated during the excavation and pulverization process and as aerosols generated during the reagent/waste mixing process. Although construction practices would minimize the occurrences of releases during the implementation of this process, the short-term releases would still potentially jeopardize human health and the environment. Thus, the effectiveness of the stabilization/solidification process is reduced in the short-term, which is the environmental trade-off necessary to potentially increase long term effectiveness and permanence. Due to the relatively high probability of potential releases and exposure over the construction timeframe for the solidification/stabilization process, Alternative 5 has an extremely low degree of short-term effectiveness.

Implementability

The stabilization/solidification process would require a relatively complex effort that must be carefully planned and managed in order to assure optimum results. The process would require a very large mobilization of equipment including hammermills, hoppers, conveyors, trucks and backhoes. Furthermore, implementation of this process would require a significant amount of earthwork, approximately eight acres for staging, and two acres for a lagoon, that is necessary to process the wastes and mix the reagents. The timeframe for processing the wastes and applying the reagents is expected to be six months to a year, depending on the actual volume of waste material unearthed from the landfill. When considering the time to stabilize/solidify and apply a final cover to the treated waste, this alternative would require approximately one and one-half to two years to implement.

Costs

The capital costs associated with implementing Alternative 5 are estimated to be $16,724,000. The annual O&M costs associated with this alternative are estimated to be $45,000 per year. This O&M cost is related to cover and fence maintenance and ground water monitoring. By applying a 5% discount rate over a 30 year maintenance period, the total present worth associated with Alternative 5 is estimated to be $17,416,000. A summary of the costs estimates for Alternative 5 is presented in Table 5-9.

State Acceptance

The assessment of state acceptance cannot be made until after the state provides its input to the USEPA's Proposed Plan.

Table 5-9. Cost Analysis of Alternative 5 for the Old City Landfill, Columbus, Indiana

The following cost estimates apply to Alternative 5 which consists of Stabilization/Solidification and Institutional Controls.

CAPITAL REQUIREMENTS	COST
Construction of Gravel Access Road (Lump Sum)	$ 2,500
Clearing and Grubbing of Staging/Lagoon Areas (10 acres @ $ 150/acre)	$ 150,000
Preparation of Staging Area (8 acres @ $ 3,400/acre)	$ 27,000
Creation of Lagoons (2 Units of 1 acre each)	$ 22,000
Construction of Levee (Lump Sum)	$ 78,000
Purchase of Reagents (Lump Sum)	$ 5,685,000
Hauling of Reagents (Lump Sum)	$ 3,500,000
Equipment Rental and Labor (includes 1 Hammermill, 2 Shredders, 5 Backhoes, 1 Loader, and 1 12-Ton Dump Truck)	$ 1,300,000
Placement and Compaction of Top Soil (0.5 ft over 21 acres, or 17,000 cy @ $8.75/cy)	$ 149,000
Seeding of Vegetation Cover (21 acres @ $1,600/acre)	$ 34,000
Construction Oversight (Lump Sum)	$ 180,000

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Table 5-9. Cost Analysis of Alternative 5 for the Old City Landfill, Columbus, Indiana (continued)

The following cost estimates apply to Alternative 5 which consists of Solidification/Stabilization and Institutional Controls.

Subtotal	$11,151,000
Engineering (15%)	$ 1,672,000
Contingency (15%)	$ 1,672,000
Design/Bench Test (10%)	$ 1,115,000
Health and Safety (10%)	$ 1,115,000
TOTAL CAPITAL COST	**$16,724,000**
ANNUAL O & M REQUIREMENTS	
Cover Inspection and Maintenance	$ 20,000/year
Ground-Water Monitoring	$ 20,000/year
Fence Inspection and Maintenance	$ 5,000/year
ANNUAL O & M COST	**$ 45,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate)	**$17,416,000**

Community Acceptance

The assessment of community acceptance can not be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan.

5.13 ALTERNATIVE 5A: ROADWAY PLACEMENT WITH SOLIDIFICATION/ STABILIZATION

Alternative 5A would combine placement of the proposed roadway with treatment of the entire landfill waste by solidification/stabilization. Institutional controls would also be implemented as part of this alternative.

5.13.1 Detailed Description

Apart from the differences discussed below, the process of solidifying/stabilizing the waste material that was discussed in Section 5.12.1 for Alternative 5 also applies to Alternative 5A. The institutional controls discussed in Section 5.7.1 for Alternative 2 would also be provided for Alternative 5A to compliment the solidification/stabilization process. Except for the differences noted below, placement of the roadway would be accomplished as previously discussed in Section 5.5.1 for Alternative 1A.

The critical aspects of Alternative 5A would be coordinating the construction activities related to placement of the roadway with the excavation, processing and treatment activities associated with stabilization/solidification of the wastes. To ensure that these aspects are properly addressed, the design and construction sequence for the proposed roadway and the stabilization/solidification process as discussed previously would have to be altered.

Prior to constructing the roadway, approximately 50,000 cubic yards of waste and existing cover material would have to be removed and stock piled in an earthen basin which would be optimally constructed in the southeast portion of the landfill. The same amount of backfill would be necessary to fill the void created by the excavation. Since the cavity created by excavating the wastes beneath the proposed roadway would be filled with earthen material and compacted in accordance with engineering specifications, subsidence would no longer be considered a problem. A pre-construction loading program would still be implemented on the clean backfill over a short period of time in order to further compact the fill material. During this compaction phase the stabilization/solidification of the excavated waste may commence at the southeast portion of the landfill away from the road.

The sequencing of construction of the roadway and treatment of the existing wastes in the landfill would require a two-stage process. In the first stage, treatment of the southeast portion of the landfill would be initiated while the road is under construction in order to avoid conflicts between the two activities. As the schedule of road construction is completed, stabilization/solidification of the landfill would progress until the southeast section of the landfill up to the roadway is finished. Subsequently, the second stage of treatment would be implemented, whereby the northwest sector of the landfill would be excavated, the waste sorted and treated. The staging, sorting and treatment would be arranged in the area available between the landfill and the river. A temporary levee would likely be necessary to provide flood protection of any excavated waste material.

Following construction of the roadway and treatment of the wastes adjacent to the roadway, a vegetative cover would be placed over the stabilized/solidified mass that would be buried back in the OCL. This cover would be properly graded to promote surface water run-off from the roadway and the remaining landfill area.

5.13.2 Assessment

The results of assessing Alternative 5A against the nine evaluation criteria are presented below.

Overall Protection of Human Health and Environment

The assessment of solidification/stabilization and institutional controls presented in Section 5.12.2 for Alternative 5 equally applies to the assessment of Alternative 5A. The inclusion of the roadway as part of Alternative 5A does not adversely affect the overall protection provided by the stabilization/solidification of the waste material. However, the low degree of short-term effectiveness, discussed in Section 5.12.2, is further reduced for alternative 5A due to the large volume of waste material that would have to be excavated and temporarily stored on site prior to treatment in order to accommodate placement of the roadway.

Although it would provide a high degree of long-term effectiveness and permanence, Alternative 5A would only provide a moderate degree of overall protection of human health and the environment due to the high potential for contaminant releases during its implementation.

Compliance with ARARs

All chemical-specific ARARs are currently being met. As stated in Section 5.12.2, the solidification/stabilization process would ensure that chemical-specific ARARs would not be exceeded in the future by eliminating or significantly reducing the long-term potential for contaminant releases. Provided that the solidification/stabilization process would be effective to the point where the treated waste could pass the TCLP test, then all location and action-specific ARARs would be met.

Long-Term Effectiveness and Permanence

The assessment of long-term effectiveness and permanence presented in Section 5.12.2 for Alternative 5 also applies to Alternative 5A.

Reduction of Toxicity, Mobility, and Volume through Treatment

The assessment of the degree of treatment provided by solidification/stabilization presented in Section 5.12.2 for Alternative 5 also applies to Alternative 5A.

Short-Term Effectiveness

The assessment of short-term effectiveness presented in Section 5.12.2 for Alternative 5 also applies to Alternative 5A.

Implementability

As stated in Section 5.12.2, the solidification/stabilization process would require an intensive mobilization and utilization of equipment, materials, and manpower. Implementation of the process for Alternative 5A would be further compounded by coordinating the excavation and treatment process with placement of the roadway. The waste material underlying the line of the roadway would first have to be excavated and replaced with standard fill material. The placement of the roadway would, thus, serve to dissect the landfill. As a result of the roadway, two separate staging areas would be required for storing, pulverizing, and treating the excavated waste material. This would extend the time and effort required for fully implementing the solidification/stabilization process.

Costs

The capital costs associated with implementing Alternative 5A are estimated to be $17,142,000. This is greater than the capital costs estimated for Alternative 5, because it accounts for the double staging required to implement the solidification/stabilization process. It does not include, however, the costs of the fill material required to fill the excavation along the line of the roadway. The annual O&M costs associated with Alternative 5A are estimated to be $45,000. By applying a 5% discount rate over a 30 year maintenance period, the total present worth associated with Alternative 5A is estimated to be $17,834,000. A summary of the cost estimates for Alternative 5A is presented in Table 5-10.

State Acceptance

The assessment of state acceptance cannot be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The assessment of community acceptance cannot be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan. It is anticipated, however, that the community would be in strong support of the proposed roadway and bridge.

5.14 COMPARISON OF ALTERNATIVES

The previous sections presented the assessment of the individual alternatives against the nine evaluation criteria. During this assessment, each of the evaluation criteria was given equal

Table 5-10. Cost Analysis of Alternative 5A for the Old City Landfill, Columbus, Indiana

The following cost estimates apply to Alternative 5A which consists of Stabilization/ Solidification, Roadway Placement, and Institutional Controls. Costs for roadway are not included.

CAPITAL REQUIREMENTS	COST
Construction of Gravel Access Road (Lump Sum)	$ 2,500
Clearing and Grubbing of Staging/Lagoons Areas (10 acres @ $ 150/acre)	$ 150,000
Preparation of Two Staging Areas (16 acres @ $ 3,400/acre)	$ 54,000
Creation of Lagoons (2 Units of 1 acre each)	$ 22,000
Construction of Levees (Lump Sum)	$ 156,000
Construdction of Earthen Storage Basin	$ 75,000
Purchase of Reagents (Lump Sum)	$5,685,000
Hauling of Reagents (Lump Sum)	$3,500,000
Equipment Rental and Labor (includes 1 Hammermill, 2 Shredders, 5 Backhoes, 1 Loader, and 1 12-Ton Dump Truck)	$1,300,000
Movement of Process System	$ 80,000
Placement and Compaction of Top Soil (0.5 ft over 21 acres, or 17,000 cy @ $8.75/cy)	$ 149,000

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Table 5-10. Cost Analysis of Alternative 5A for the Old City Landfill, Columbus, Indiana (continued)

The following cost estimates apply to Alternative 5A which consists of Solidification/ Stabilization, Roadway Placement, and Institutional Controls. Costs for roadway are not included.

Seeding of Vegetation Cover (21 acres @ $1,600/acre)		$ 34,000
Construction Oversight (Lump Sum)		$ 220,000
	Subtotal	$11,428,000
Engineering (15%)		$ 1,714,000
Contingency (15%)		$ 1,714,000
Design/Bench Test (10%)		$ 1,143,000
Health and Safety (10%)		$ 1,143,000
	TOTAL CAPITAL COST	**$17,142,000**
ANNUAL O & M REQUIREMENTS		
Cap Inspection and Maintenance		$ 20,000/year
Ground-Water Monitoring		$ 20,000/year
Fence Inspection and Maintenance		$ 5,000/year
	ANNUAL O & M COST	**$ 45,000/year**
TOTAL PRESENT WORTH (over 30 years, at 5 % discount rate; not including the cost of roadway)		**$17,834,000**

weight and it was determined to what degree the alternative would either meet or not meet each of the evaluation criteria. Summaries of the evaluations made for each of the Alternatives are presented in Tables 5-11 through 5-20. To establish the relative advantages and disadvantages of the remedial alternatives a comparison analysis is performed in which all of the alternatives are evaluated against each of the evaluation criteria. The comparative analysis, the results of which are presented in this section, establishes what trade-offs exist between the various alternatives.

In comparing the alternatives, it must be noted that the latest revisions to the NCP, 40 CFR 300.430 (e)(9)(f), assign relative levels of importance to the nine evaluation criteria. The relative levels of the evaluation criteria and their importance to the comparative analysis and selection of the preferred alternative, are presented below.

- Threshold Criteria: Overall protection of human health and the environment and compliance with ARARs, unless a specific ARAR is waived, are threshold requirements that each alternative must meet in order to be eligible for selection.

- Primary Balancing Criteria: Long-term effectiveness and permanence, reduction of toxicity, mobility or volume through treatment, short-term effectiveness, implementability, and cost are the five primary balancing criteria. These primary balancing criteria are used to address the major trade-offs between the remedial alternatives.

- Modifying Criteria: State and community acceptance are modifying criteria which will be considered by the regulatory agencies in the selection of the final remedy. The impact of state and community acceptance to the remedy selection process will be addressed in the Record of Decision (ROD).

Table 5-11. Detailed Analysis Summary of Remedial Alternative 1 for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 1
NO ACTION

Protection of Human Health and the Environment		o	Marginally adequate because existing risks are within acceptable health-based and environmental quality-based guidelines.
		o	Would not provide environmental monitoring, thus, there would be no means to identify and control any future risks that would result from contaminant releases.
Compliance with ARARs		o	Chemical-specific ARARs are currently are being met. Action-specific and location-specific ARARs would not apply.
Long-Term Effectiveness and Permenance		o	Low degree of long-term effectiveness in ensuring the contined protection of human health and the environment.
		o	Permanence not relevant to this alternative.
Reduction of Toxicity, Mobility, or Volume through Treatment		o	No treatment is employed.
Short-Term Effectiveness		o	High degree because currently acceptable risks would not be increased.
Implementability		o	Not applicable.
State Acceptance		o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance		o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs.	Capital Costs	o	No remedial capital costs for this alternative.
	O & M Costs	o	No remedial O&M costs for this alternative.
	Present Worth (30 years, 5%)	o	Not applicable.

Table 5-12. Detailed Analysis Summary of Remedial Alternative 1A for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 1A
ROADWAY PLACEMENT WITH NO ACTION

Protection of Human Health and the Environment	o	Would not adequately ensure the continued protection of human health and the environment because there would be no means for monitoring or controlling any contaminant releases that could occur in the future.
	o	Placement of the roadway would cause compaction of the waste material, thus, increasing the potential for leachate generation.
Compliance with ARARs	o	All chemical-specific ARARs are currently being met.
	o	Placement of the roadway would comply with all location and action-specific ARARs.
Long-Term Effectiveness and Permanence	o	Low degree of long-term effectiveness in ensuring the continued protection of human health and the environment.
	o	Permanence is not relevant to this alternative.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	Moderately low degree since there would be a potential for disturbing or exposing the waste material during construction activities.
Implementability	o	Placement of the roadway could be implemented without excessive difficulties.
State Acceptance	o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance	o	Determined by public comments received during the public comment period on the USEPA's Proposed Plan.
Costs. Capital Costs	o	No remedial capital costs for this alternative.
O & M Costs	o	No remedial O&M costs for this alternative.
Present Worth (30 years, 5%)	o	Not applicable.

Table 5-13. Detailed Analysis Summary of Remedial Alternative 2 for the Old City Landfill, Columbus, Indiana

		REMEDIAL ALTERNATIVE 2 INSTITUTIONAL CONTROLS
Protection of Human Health and the Environment	o	Would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases.
	o	If contaminant releases were to occur some time in the future, appropriate remedial action could be taken prior to the contaminants entering a viable exposure pathway.
Compliance with ARARs	o	Chemical-specific ARARs are currently being met.
Long-Term Effectiveness and Permanence	o	Access and deed restrictions would provide long-term effectiveness and permanence in preventing direct contact with, or ingestion of, the waste material or any ground water that may become impacted in the future.
	o	The landfill cover maintenance program would ensure that the waste material is not subjected to surface exposure.
	o	Ground-water monitoring is a proven and reliable means for determining if contaminant releases were occurring.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	High degree because currently acceptable risks would not be increased during implementation of the remedial actions.
Implementability	o	All of the individual actions for this alternative could be readily implemented.
State Acceptance	o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance	o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs. Capital Costs	o	$ 160,000
O & M Costs	o	$ 45,000/year
Present Worth (30 years, 5%)	o	$ 852,000

Table 5-14. Detailed Analysis Summary of Remedial Alternative 2A for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 2A
ROADWAY PLACEMENT WITH INSTITUTIONAL CONTROLS

Protection of Human Health and the Environment	o	Would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases.
	o	The placement of the roadway may increase the potential for leachate generation; however, additional institutional control measures would be implemented to abate any environmental impacts caused by leachate generation.
	o	If contaminant releases were to occur some time in the future, appropriate remedial action could be taken prior to the contaminants entering a viable exposure pathway.
Compliance with ARARs	o	All chemical-specific ARARs are currently being met.
	o	Remedial and roadway placement actions would comply with all location and action-specific ARARs.
Long-Term Effectiveness and Permanence	o	Access and deed restrictions would provide long-term effectiveness and permanence in preventing direct contact with, or ingestion of, waste material or any ground water that may become impacted in the future.
	o	The landfill cover maintenance and leachate seep inspection program would ensure that the waste material is not subjected to surface exposure and that leachate seeps do not form.
	o	Ground-water monitoring is a proven and reliable means for determining if contaminant releases were occurring.
	o	The ground-water recovery system implementation plan would be effective in ensuring expeditious implementation of ground-water cleanup actions, should they be warranted in the future.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	Moderately low degree since there would be a potential for disturbing or exposing the waste material during construction activities.
Implementability	o	All of the individual actions for this alternative could be readily implemented.
State Acceptance	o	Determined by state and to be reflected in USEPA's Proposed Plan.

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Table 5-14. Detailed Analysis Summary of Remedial Alternative 2A for the Old City Landfill, Columbus, Indiana (continued)

Community Acceptance		o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs.	Capital Costs	o	$ 260,000 (not including roadway)
	O & M Costs	o	$ 75,000/year
	Present Worth (30 years, 5%)	o	$1,413,000 (not including roadway)

Table 5-15. Detailed Analysis Summary of Remedial Alternative 3 for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 3
SANITARY LANDFILL CAP

Protection of Human Health and the Environment	o	Sanitary landfill cap would reduce the potential for direct contact with, or ingestion of, the waste material.
	o	The clay layer in the cap would reduce infiltration into the waste material, thus, decreasing the long-term potential for leaching of contaminants.
	o	The institutional controls would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases.
Compliance with ARARs	o	Chemical-specific ARARs are currently being met.
	o	Assuming that the sanitary landfill cap would be approved by the regulatory agencies, all location and action-specific ARARs would be met.
Long-Term Effectiveness and Permanence	o	A sanitary landfill cap would provide long-term effectiveness and permanence in minimizing the potential for surface exposure of, and infiltration into, the waste material.
	o	The institutional controls would provide long-term effectiveness and permanence in limiting site access, controlling land and ground-water use, and monitoring the ground-water to determine if additional remedial action would be required.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	With proper dust and grading control measures, the potential for surface exposure of the waste material could be minimized.
Implementability	o	The remedial actions could be implemented without difficulty although the cap would require appreciable time for design and construction.
State Acceptance	o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance	o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs. Capital Costs	o	$ 2,307,000
O & M Costs	o	$ 45,000/year
Present Worth (30 years, 5%)	o	$ 2,999,000

Table 5-16. Detailed Analysis Summary of Remedial Alternative 3A for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 3A
ROADWAY PLACEMENT WITH SANITARY LANDFILL CAP

Protection of Human Health and the Environment	o	Sanitary landfill cap would reduce the already low potential for direct contact with, or ingestion of, the waste material.
	o	The clay layer in the cap would reduce infiltration into the waste material, thus, decreasing the long-term potential for leaching of contaminants.
	o	The placement of the roadway may increase the potential for leachate generation due to the waste compaction, however, additional institutional control measures would be implemented to abate any environmental impacts caused by leachate generation.
	o	Institutional controls would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases.
Compliance with ARARs	o	All chemical-specific ARARs are currently being met.
	o	Assuming that the sanitary landfill cap would be approved by the regulatory agencies, all location and action-specific ARARs would be met.
Long-Term Effectiveness and Permanence	o	A sanitary landfill cap would provide long-term effectiveness and permanence in minimizing the potential for surface exposure of, and infiltration into, the waste material.
	o	The institutional controls would provide long-term effectiveness and permanence in limiting site access, controlling land and ground-water use, and monitoring the ground-water to determine if additional remedial action would be required.
	o	The ground-water recovery system implementation plan would be effective in ensuring expeditious implementation of ground-water cleanup actions, should they be warranted in the future.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	With proper dust and grading control measures, the potential for surface exposure of the waste material could be minimized.
Implementability	o	Implementation of the sanitary landfill cap and institutional controls in combination with the roadway would be technically feasible.
	o	Required construction sequence would delay implementation of the cap and may potentially delay completion of the roadway and bridge.

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Table 5-16. Detailed Analysis Summary of Remedial Alternative 3A for the Old City Landfill, Columbus, Indiana (continued)

State Acceptance		o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance		o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs.	Capital Costs	o	$ 2,439,000 (not including roadway)
	O & M Costs	o	$ 75,000/year
	Present Worth (30 years, 5%)	o	$ 3,592,000 (not including roadway)

Table 5-17. Detailed Analysis Summary of Remedial Alternative 4 for the Old City Landfill, Columbus, Indiana

		REMEDIAL ALTERNATIVE 4 RCRA SUBTITLE C CAP
Protection of Human Health and the Environment	o	RCRA Subtitle C cap would reduce the already low potential for direct contact with, or ingestion of, the waste material.
	o	The flexible membrane liner and clay layer in the cap would reduce infiltration into the waste material, thus, decreasing the long-term potential for leaching of contaminants.
	o	The institutional controls would ensure the continued protection of human health and the environment by minimizing sites access, controlling land and ground-water use, and monitoring for contaminant releases.
Compliance with ARARs	o	Chemical-specific ARARs are currently being met.
	o	Assuming that the RCRA Subtitle C Cap would be approved by the regulatory agencies, all location and action-specific ARARs would be met.
Long-Term Effectiveness and Permanence	o	RCRA Subtitle C Cap would provide long-term effectiveness and permanence in minimizing the potential for surface exposure of, and infiltration into, the waste material.
	o	The institutional controls would provide long-term effectiveness and permanence in limiting site access, controlling land and ground-water use, and monitoring the ground-water to determine if additional remedial action would be required.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	With proper dust and grading control measures, the potential for surface exposure of the waste material could be minimized.
Implementability	o	The remedial actions could be implemented without difficulty although the cap would require appreciable time for design and construction.
State Acceptance	o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance	o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs. Capital Costs	o	$ 5,057,000
O & M Costs	o	$ 45,000/year
Present Worth (30 years, 5%)	o	$ 5,749,000

Table 5-18. Detailed Analysis Summary of Remedial Alternative 4A for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 4A
ROADWAY PLACEMENT WITH RCRA SUBTITLE C CAP

Protection of Human Health and the Environment	o	RCRA Subtitle C Cap would reduce the already low potential for direct contact with, or ingestion of, the waste material.
	o	The flexible membrane liner and clay layer in the cap would reduce infiltration into the waste material, thus, decreasing the long-term potential for leaching of contaminants.
	o	The placement of the roadway may increase the potential for leachate generation due to the waste compaction; however, additional institutional control measures would be implemented to abate any environmental impacts caused by leachate generation.
	o	Institutional controls would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases.
Compliance with ARARs	o	All chemical-specific ARARs are currently being met.
	o	Assuming that the RCRA Subtitle C Cap would be approved by the regulatory agencies, all location and action-specific ARARs would be met.
Long-Term Effectiveness and Permanence	o	RCRA Subtitle C Cap would provide long-term effectiveness and permanence in minimizing the potential for surface exposure of, and infiltration into, the waste material.
	o	The institutional controls would provide long-term effectiveness and permanence in limiting site access, controlling land and ground-water use, and monitoring the ground-water to determine if additional remedial action would be required.
	o	The ground-water recovery system implementation plan would be effective in ensuring expeditious implementation of ground-water cleanup actions, should they be warranted in the future.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	No treatment is employed.
Short-Term Effectiveness	o	With proper dust and grading control measures, the potential for surface exposure of the waste material could be minimized.
Implementability	o	Implementation of the RCRA Subtitle C Cap and institutional controls in combination with the roadway would be technically feasible.

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Table 5-18. Detailed Analysis Summary of Remedial Alternative 4A for the Old City Landfill, Columbus, Indiana (continued)

Implementability (cont.)		o	Required construction sequence would delay implementation of the cap and may potentially delay completion of the roadway and bridge.
State Acceptance		o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance		o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs.	Capital Costs	o	$ 5,191,000 (not including roadway).
	O & M Costs	o	$ 75,000/year
	Present Worth (30 years, 5%)	o	$ 6,344,000 (not including roadway).

Table 5-19. Detailed Analysis Summary of Remedial Alternative 5 for the Old City Landfill, Columbus, Indiana

REMEDIAL ALTERNATIVE 5
ON-SITE SOLIDIFICATION/STABILIZATION

Protection of Human Health and Environment		o	Solidification/stabilization process would eliminate or significantly reduce the long-term potential for contaminant releases from the treated waste material.
		o	Excavation and pulverizing up to 500,000 cubic yards of waste material would likely cause contaminant releases during implementation of the solidification/stabilization process.
		o	Since contaminant releases would likely occur during its implementation, Alternative 5 would only provide a moderate degree of overall protection of human health and the environment.
Compliance with ARARs		o	All chemical-specific ARARs are currently being met.
		o	Once the entire volume of waste would be treated, chemical-specific ARARs would continue to be met.
		o	Provided that the waste could be treated to a level such that RCRA LDRs would not apply, all location and action-specific ARARs would be met.
Long-Term Effectiveness and Permanence		o	The solidification/stabilization process would provide a high degree of long-term effectiveness and permanence because it would eliminate or significantly reduce the potential for contaminant releases to occur once the entire volume of waste material would be treated.
Reduction of Toxicity, Mobility, or Volume through Treatment		o	Solidification/stabilization would reduce the mobility, and possibly of the toxicity of the contaminants within the waste material.
		o	The volume of contaminants would not be reduced.
Short-Term Effectiveness		o	Extremely low degree of short-term effectiveness due to the high potential for contaminant releases during excavation, pulverization and treatment of up to 500,000 cubic yards of waste material.
Implementability		o	Requires an intensive mobilization and utilization of equipment, materials, and manpower.
		o	May require up to two years to complete the remedial action.
State Acceptance		o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance		o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.
Costs.	Capital Costs	o	$ 16,724,000
	O & M Costs	o	$ 45,000/year
	Present Worth (30 years, 5%)	o	$ 17,416,000

Table 5-20. Detailed Analysis Summary of Remedial Alternative 5A for the Old City Landfill, Columbus, Indiana

		REMEDIAL ALTERNATIVE 5A ON-SITE SOLIDIFICATION/STABILIZATION
Protection of Human Health and Environment	o	Solidification/stabilization process would eliminate or significantly reduce the long-term potential for contaminant releases from the treated waste material.
	o	Excavation and pulverizing up to 500,000 cubic yards of waste material would likely cause contaminant releases during implementation of the solidification/stabilization process.
	o	Since contaminant releases would likely occur during its implementation, Alternative 5A would only provide a moderate degree of overall protection of human health and the environment.
Compliance with ARARs	o	All chemical-specific ARARs are currently being met.
	o	Once the entire volume of waste would be treated, chemical-specific ARARs would continue to be met.
	o	Provided that the waste could be treated to a level such that RCRA LDRs would not apply, all location and action-specific ARARs would be met.
Long-Term Effectiveness and Permanence	o	The solidification/stabilization process would provide a high degree of long-term effectiveness and permanence because it would eliminate or significantly reduce the potential for contaminant releases to occur once the entire volume of waste material would be treated.
Reduction of Toxicity, Mobility, or Volume through Treatment	o	Solidification/stabilization would reduce the mobility, and possibly the toxicity of the contaminants within the waste material.
	o	The volume of contaminants would not be reduced.
Short-Term Effectiveness	o	Extremely low degree of short-term effectiveness due to the high potential for contaminant releases during excavation, pulverization and treatment of up to 500,000 cubic yards of waste material.
Implementability	o	Requires an intensive mobilization and utilization of equipment, materials, and manpower.
	o	May require up to two year to complete the remedial action.
	o	Combining the solidification/stabilization process with placement of the roadway would require temporary above-ground storage of a portion of the excavated waste material and multiple staging areas for treating the waste material.
State Acceptance	o	Determined by state and to be reflected in USEPA's Proposed Plan.
Community Acceptance	o	Determined by comments received during the public comment period on the USEPA's Proposed Plan.

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Table 5-20. **Detailed Analysis Summary of Remedial Alternative 5A for the Old City Landfill, Columbus, Indiana (continued)**

Costs.	Capital Costs	o	$ 17,142,000
	O & M Costs	o	$ 45,000/year
	Present Worth (30 years, 5%)	o	$ 17,834,000

The results of the comparative analysis, in which all of the remedial alternatives are evaluated collectively against each of the evaluation criteria, are presented below. The comparative analyses are presented under the three levels of evaluation criteria.

5.14.1 Threshold Criteria

Each alternative must meet both threshold criteria, unless a waiver is issued for a specific ARAR, in order to eligible for selection.

Overall Protection of Human Health and the Environment

In its present condition, the OCL does not present a risk to human health and the environment, as determined by the baseline risk assessment (G&M 1990a). The determination of the overall protection of human health and the environment provided by an alternative, thus, has to be made based on the degree to which the alternative would ensure the current risks to human health and the environment are not increased. The key aspect of this determination is whether an alternative would be able to minimize or control future releases of contaminants prior to the contaminants entering a potential pathway of exposure.

Alternatives 1 and 1A would not ensure the overall protection of human health and the environment since there would be no means to identify and mitigate any increased risks that could result from contaminant releases occurring some time in the future. Due to the increased potential for leachate generation as a result of waste material compaction by the roadway fill placement, Alternative 1A would provide a lower degree of overall protection than would Alternative 1. Since Alternatives 1 and 1A would not adequately meet this threshold criteria they cannot be selected as the final remedy. Alternatives 1 and 1A are, thus, eliminated form further consideration.

The institutional controls provided under Alternatives 2 and 2A would ensure the continued protection of human health and the environment by minimizing site access, controlling land and ground-water use, and monitoring for contaminant releases. As a result of the monitoring and inspection measures that would be implemented, appropriate remedial action could be taken, if contaminant releases were to occur, prior to having the contaminants migrate off-site. To abate any environmental impacts caused by the generation of leachate from placement of the roadway, Alternative 2A would include additional control measures (i.e. leachate seep inspections and the development of a ground-water recovery system contingency plan) to ensure the same degree of overall protection provided by Alternative 2.

The landfill capping alternatives, 3, 3A, 4 and 4A would also ensure the continued protection of human health and the environment. In fact, measured against Alternatives 2 and 2A, Alternatives 3, 3A, 4 and 4A would provide a slightly higher degree of overall protection since, in addition to institutional controls, they would incorporate enhanced waste containment by capping the landfill. By covering the landfill with an engineered cap, the potential for surface exposure of, ingestion of, and direct contact with, the waste material would be reduced, although the current potential for such events is very low.

With placement of an engineered cap over the landfill, the amount of water infiltration into the waste material would be reduced, thus, limiting the potential for the leaching of contaminants into the underlying ground-water. Due to the more stringent requirements associated with a RCRA Subtitle C Cap, Alternative 4 and 4A would provide a greater degree of water infiltration reduction than would Alternatives 3 and 3A. The potential benefit of reduced infiltration might not be realized at the OCL since significant releases of contaminants into the ground water were not detected during the RI even though infiltration has percolated through the existing landfill cover and the waste material over the past years. The lack or identified releases of contaminants due to leaching is consistent with the fact that the vast majority of the constituents of concern in the waste material are heavy metals which are relatively immobile in the environment. As is the case with Alternatives 1 and 1A (although they have been eliminated from further consideration) and Alternatives 2 and 2A, the landfill cap alternatives would also not reduce the potential for the leaching of contaminants into the ground water as a result of the water table rising up into the landfill waste material. By properly coordinating the construction sequence, placement of the roadway in combination with either an Indiana Sanitary Landfill Cap or a RCRA Subtitle C Cap would not significantly alter the overall degree of protection provided by Alternative 3A and Alternative 4A, respectively.

By solidifying/stabilizing the entire volume of waste material within the OCL, Alternatives 5 and 5A would eliminate or significantly reduce the long-term potential for contaminant releases from the treated waste material. Alternatives 5 and 5A would provide the highest degree of overall protection once the entire volume of waste were treated; however, excavation, pulverization, and treatment of up to 500,000 cubic yards of waste material would likely cause contaminant releases during implementation of the solidification/stabilization process. Thus, although the potential for future contaminant releases would be eliminated or significantly reduced once the treatment would be completed, Alternatives 5 and 5A would only provide a moderate degree of overall protection when measured against Alternatives 2, 2A, 3, 3A, 4 and 4A.

Based on the above discusion, all of the alternatives except Alternatives 1 and 1A would provide an acceptable degree of overall protection of human health and the environment and, thus, qualify for selection as the final remedy. As stated previously, Alternatives 1 and 1A have been elimianted from further consideration.

Compliance with ARARs

At the present time, all chemical-specific ARARs are being met for the environmental media at the OCL site. The exceedence of chemical-specific ARARs would only arise in the future if significant releases of contaminants were to occur from the landfill waste material into the other environmental media. Due to the apparent physically inert nature of the landfill waste material, it is unlikely that significant releases of contaminants would occur in the future and, thus, all of the alternatives would likely continue to meet the chemical-specific ARARs. Alternatives 2, 2A, 3, 3A, 4 and 4A would comply with all of their respective action-specific ARARs. Alternatives 5 and 5A would also comply with their respective action-specific ARARs assuming that the degree of treatment provided by the solidification/stabilization process would be sufficient to pass the TCLP limits. If TCLP limits could not be met, then Alternatives 5 and 5A would have to incorporate some other means of treatment or require a waiver so as not to be subjected to RCRA LDR regulations. Assuming that the regulatory agencies would approve the necessary site activities, for any of the alternatives, all of the alternatives would comply with the location-specific ARARs. Compliance with location-specific ARARs, however, will require flood control measures to be taken for any waste material exposed during implementation of the selected alternative.

5.14.2 Primary Balancing Criteria

The following primary balancing criteria are used to address the major trade-offs between the remedial alternatives.

Long-Term Effectiveness and Permanence

The institutional controls provided for Alternatives 2 and 2A would provide long-term effectiveness and permanence in ensuring the continued protection of human health and the environment. Access and deed restrictions would prevent direct contact with, or ingestion of, the waste material or any ground water thay may become impacted in the future. The landfill cover maintenance program would ensure the waste material would not be subjected to surface exposure. In addition, ground-water monitoring would be a reliable means for determining if contaminant releases were occurring. To ensure that placement of the roadway would not jeopardize human health and the environment, Alternative 2A would incorporate leachate seep inspections and the development of a ground-water recovery system contingency plan. Both of these additional measures would provide long-term effectiveness in ensuring expeditious implementation of cleanup actions, should they be warranted in the future.

Alternatives 3, 3A, 4 and 4A would provide a slightly higher degree of long-term effectiveness and permanence than would Alternatives 2 and 2A because, in addition to institutional controls, they would also incorporate enhanced waste containment. By employing an engineered cap over the landfill, Alternatives 3, 3A, 4 and 4A would decrease the potential for surface exposure to, and water infiltration into, the waste material. However, since significant contaminant releases have not been identified under existing infiltration conditions, the benefit of an engineered cap in ensuring the continued protection of human health and the environment may be limited. Due to the stringent design and construction requirements placed on a RCRA Subtitle C Cap, Alternatives 4 and 4A would provide a higher degree of waste containment, and, thus, a higher degree of long-term effectiveness and permanence, than would Alternatives 3 and 3A, which incorporate a sanitary landfill cap. The existence and operation of the roadway would not reduce the long-term effectiveness and permanence of either an Indiana Sanitary Landfill Cap or a RCRA Subtitle C Cap.

By solidifying/stabilizing the entire volume of waste material within the OCL, Alternatives 5 and 5A would eliminate or significantly reduce the potential for contaminant releases to occur once the entire volume of waste would be treated. Since the treated waste would be in a stabilized matrix form the eliminated or significantly reduced potential for contaminant releases would be relatively permanent for the foreseeable future. For these reasons, Alternative 5 and 5A may provide the highest degree of long-term effectiveness and permanance of any of the alternatives.

Reduction of Toxicity, Mobility or Volume through Treatment

Of all the alternatives, only Alternatives 5 and 5A would incorporate treatment. The solidification/stabilization process provided as part of Alternatives 5 and 5A would reduce the mobility, and possibly the toxicity, of the contaminants within the OCL waste material, but would not reduce their volume. The degree of treatment provided by the solidification/stabilization process would have to be established based on the results of laboratory tests.

Short-Term Effectiveness

The existing risks associated with the OCL, in its current condition, are within acceptable health-based and environmental quality-based guidelines. As a result, for an alternative to provide short-term effectiveness, it must not increase the risks to human health and the environment.

Alternative 2 would provide a high degree of short-term effectiveness because the waste material would not be disturbed or exposed during implementation of the institutional controls. Alternative 2A would have a slightly lower degree of short-term effectiveness because a very small portion of the waste material could be disturbed or exposed during roadway placement activities.

Alternatives 3, 3A, 4 and 4A would provide a moderately low degree of short-term effectiveness because the waste material could become exposed during scarification and regrading of the existing landfill cover which would be required prior to placement of the cap.

Alternatives 5 and 5A would have an extremely low degree of short-term effectiveness due to the high potenital for contaminant releases during excavation, pulverization and treatment of up to 500,000 cubic yards of waste material.

Implementation

The institutional controls provided for Alternatives 2 and 2A, and also included as part of the other alternatives, could all be readily implemented. Implementation of the institutional controls for Alternative 2A would not be impacted by placement of the roadway. Alternatives 3 and 4 could be implemented without excessive difficulties, although both an Indiana Sanitary Landfill Cap and a RCRA Subtitle C Cap would require appreciable time for design and construction. Not considering the time to construct the roadway, Alternatives 2 and 2A could be implemented within a one year period.

The combination of either an Indiana Sanitary Landfill Cap or a RCRA Subtitle C Cap with the proposed roadway, as would be provided in Alternatives 3A and 4A, respectively, is technically feasible. Due to the required construction sequence, the time and difficulty associated with implementing either Alternatives 3A or 4A, would be greater than that required for implementing Alternatives 3 and 4. It is anticipated that Alternatives 3, 3A, 4 or 4A could be implemented within a 12 to 24 month period.

Of all the alternatives, Alternatives 5 and 5A would be the most difficult to implement due to the intensive mobilization and utilization of equipment, materials, and manpower that would be required. Alternatives 5 and 5A may require up to two years to complete.

Costs

The estimated costs for the alternatives reflect the amount of equipment, materials and labor required for an alternative, but are not proportional to the overall protection to human health and the environment provided by an alternative. Alternatives 2 and 2A have the lowest estimated total present worth, assuming a 5% discount rate taken over a 30 year period, of $852,000 and $1,413,000, respectively. Alternatives 3 and 3A have an estimated total present worth of $2,999,000 and $3,592,000, respectively. Alternatives 4 and 4A have an estimated total present worth of $5,749,000 and $6,344,000, respectively. Alternatives 5 and 5A have the highest estimated total present worth of $17,416,000 and $17,834,000, respectively.

5.14.3 Modifying Criteria

These criteria will be utilized to modify, if required, the final remedy based on state and community acceptance.

State Acceptance

The determination of which alternative or alternatives would be acceptable to the state cannot be made until after the state provides its input to the USEPA's Proposed Plan.

Community Acceptance

The determination of which alternative or alternatives would be acceptable to the community cannot be made until after completing the public comment period in which the public will have an opportunity to respond to the USEPA's Proposed Plan. It is anticipated that due to the community interest associated with the proposed roadway and bridge, community acceptance will factor significantly into the selection of a final remedy for the OCL.

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